ALABAMA. Geology. Tuomey. 1849

FIRST BIENNIAL REPORT

ON THE

GEOLOGY OF ALABAMA.

BY M. TUOMEY,

GEOLOGIST TO THE STATE; PROFESSOR OF GEOLOGY, ETC., IN THE UNIVERSITY OF ALABAMA.

TUSKALOOSA:
PRINTED BY M. D. J. SLADE.

1850.

TO HIS EXCELLENCY,

HENRY W. COLLIER,

GOVERNOR OF THE STATE OF ALABAMA:

SIR,

I herewith submit a Report on the Geology of Alabama.

I have the honor to be,

With great respect,

Your ob't serv't,

M. TUOMEY,

Geologist to the State.

UNIVERSITY OF ALABAMA,
Dec. 20, 1849.

ORIGIN OF THE SURVEY.

At the appointment of a Professor of Geology in the University, it was made the duty of that officer "to spend such portions of his time, not exceeding *four months* in each year, in exploring the State in connection with his proper department, as the Trustees may consider for the advantage of the State."

These explorations commenced in 1847, and have been continued up to the present time; and such extracts, from the reports made to the Trustees, as were thought to be of general interest, have appeared in the newspapers of Tuskaloosa.

In January, 1848, the following resolutions were passed by the General Assembly of the State:

"Whereas, Michael Tuomey, Professor of Mineralogy, Geology, and Agricultural Chemistry, in the University of Alabama, is required by an ordinance of the Board of Trustees of the University, to devote a portion of his time and labor, in making geological explorations, and examining into the natural resources of the State: And whereas, it would be both interesting and useful to the General Assembly, and to the people, to examine the reports which he may make from time to time: Therefore,

"*Be it Resolved by the Senate and House of Representatives of Alabama, in General Assembly convened,* That Michael Tuomey, Professor of Geology, &c. in the University of Alabama, be, and he is hereby appointed State Geologist.*

"*Be it further Resolved,* That said State Geologist be, and he is hereby required, to lay before the General Assembly of the State, at its biennial sessions, and as often as from time to

* It is proper to state, that the expenses of the survey have hitherto been defrayed by the University.

time may be thought expedient, a full report of his geological surveys and explorations, and his examinations into the mineral and other natural resources of this State."

JOHN A. WINSTON,
Speaker of the House of Representatives.
L. P. WALKER,
President of the Senate.

APPROVED, January 4th, 1848.
R. CHAPMAN,
Governor.

PREFACE.

At the commencement of the survey, two modes of conducting it presented themselves, namely:

1. To make a general reconnoisance of the State, indicating, as far as possible, its great geological features, and pointing out the direction that future explorations should take, without stopping, except in special cases, to make minute examinations.

2. To divide the State into districts, and take up each consecutively, examine it minutely, and thus proceed until the whole was explored; thereby doing thoroughly, whatever was done.

This last would doubtless be the pleasanter mode of proceeding, and would in the end save time. But for the general interests of the State, I apprehend that the first is to be preferred, and I therefore adopted it. Its advantages appear to be these: It indicates, at once, the general geological character of the State, and enables other laborers to enter the field, and fill up the outline sketch, that is thus given. When the geological structure of a country is known, this knowledge has numerous practical applications independent of details, for it enables persons to pursue investigations intelligibly, that otherwise would scarcely know where or how to begin. I have had abundant evidence of this in the number of persons I found ready to assist in my explorations, when they understood their design, and the method of prosecuting them. This general view, too, enables persons to know what is to be looked for in various parts of the State, as well as what it would be folly to expect. I am persuaded, that all things taken into consideration, I could not, in studying the geology of the State, better employ the limited time at my disposal; yet no one feels, more sensibly than I do, how little I have accomplished, when compared with what remains undone, and I could easily show how badly even that little has been executed. Those who are acquainted with the difficulties that beset preliminary explorations in thinly settled countries, will understand this; and of the

other persons into whose hands this report may fall, it only remains for me to bespeak their indulgence for its numerous faults.

In justice to those who have preceded me in the geological investigation of the State, as well as to show what was known of the geology of Alabama when the survey was begun, I present a list, containing every paper on the subject that has come under my notice:

Papers on the Geology of Alabama, in the order in which they have appeared.

1827...W. S. Porter......Silliman's Journal, Vol. XIII, p. 77.
1828...R. W. Withers.... " " Vol. XIV, p. 187.
1832...T. A. Conrad .....Fossil Shells Ter. For.
1833...Isaac Lea..........Cont. Geol.
1833...S. G. Morton......Synopsis.
1834...Alexander Jones..Sill. Jour., Vol. XXVI.
1834...C. U. Shepard....Sill. Jour., Vol. XXV, p. 162.
1835...G. Troost...........Third Ann. Rep. Geol. Tenn.
1835...S. G. Morton......Sill. Jour., Vol. XXVIII, p. 277.
1838...R. T. Brumby.....Barnard's Almanack.
1845...R. W. Withers.....Sill. Jour., Vol. XLVIII, p. 399.
1846...Lyell.................Jour. Geol. Soc., Vol. II, p. 278, 405.
1848...C. S. Hale.........Sill. Jour., N. S., Vol. VI, p. 354.

In the first number of Conrad's "Fossil Shells of the Tertiary Formations of North America," Philadelphia, 1832, there is a map, without any description, in which that part of Alabama occupied by the Palæozoic rocks, is colored to represent the "Carboniferous or Greywacke group," and a spot near Tuskaloosa is indicated as a locality of bituminous coal. This is again alluded to in Morton's Synopsis, 1834.

Prof. Troost, in his "Third Annual Report on the Geology of Tennessee," October, 1835, also mentions the carboniferous rocks in these words: "Commencing with the most southern extremity of our coal-fields, we find the coal first makes its appearance in Mount Sano, east of Huntsville, Alabama, where

it crops out in several places. This Mount Sano is a ramification of the Cumberland Mountain, which is there divided, or terminates in several ridges, running generally in a north and south direction. The coal crops out in several of the ridges, which join and form the main Cumberland Mountain near the line which separates Tennessee from Alabama."

The most extended notice of the Geology of the State, is that of Prof. Brumby, referred to above, which appeared in 1838.

In 1846, Sir Charles Lyell visited Alabama, and in alluding to Prof. Brumby's paper, and the information he derived from him, says: "It would have been impossible for me, during my short visit, to form more than a conjectural opinion respecting the structure of this coal-field, still less to determine its geographical area, had not these subjects been previously studied with great care and scientific ability by Mr. Brumby." "The most western of the two coal-fields, has been found by Prof. Brumby to be no less than ninety miles long from north-east to south-west, with a breadth of from ten to thirty miles, extending through the counties of Tuskaloosa, Walker, Jefferson and Blount, on both sides of the Warrior river and its several branches."

"The most eastern coal-field, or that of the Cahawba, is nearly of equal length and breadth."

"A third coal-field on the northern confines of the State of Alabama, is that of the Tennessee Valley. It is separated from the two former by a broad but low chain of mountains, running east and west, which intervenes between the Tennessee and the sources of the Warrior and Cahawba rivers. These mountains, according to Prof. Brumby, consist of strata older than the productive coal-measures, and similar to those seen by me in Roup's Valley."

It is possible, that in the collection examined by Sir Charles Lyell, the fossils of the Tennessee Valley were not separated from those of Roup's Valley, and hence he was led to refer the limestones of the latter, with hesitation, to the carboniferous system; for he says, after examining the coal-measures: "This group is succeeded by fetid limestones, with chert and hornstone, usually without fossils, but in some of the silicious beds of which, casts of Eucrinites, Producta, Orthis, and seve-

ral corals, abound. This inferior formation, which may perhaps belong entirely to the carboniferous series, also contains, still lower down, a limestone charged with iron; and an enormous mass of brown hematite appears to constitute a regular bed, and not a vein, and to be destined one day, like the coal, to be a source of great mineral wealth to Alabama." This is the bed of ore at Murphy's, in the midst of the silurian rocks.

The other notices of the geology of the State appertain principally to the newer formations, and reference to them will be found in the body of the report. One of these, however, deserves special notice: that is the paper by C. S. Hall, Esq., of Mobile, which contains the best account that has yet been published on the tertiary formations of Alabama.

Geological Map.—Of the map accompanying the report, I can only say, that although as accurate as the materials collected, and the extent of my observations would allow, yet it is by no means offered as a complete geological map of the State, for that would imply that the study of the geology itself was completed. It presents at a glance, a general view of the geological structure of Alabama, shows the relative position and extent of the great groups of rocks, laid down, it is true, with some approach to correctness, but it claims no more. To construct a geological map with absolute accuracy, is a work involving much time, and is rarely attempted excepting in cases where a corps of assistants can be employed. Such are the maps of the Ordnance Survey of Great Britain, where every formation is accurately laid down from actual measurement, and sections constructed with similar care.

In the construction of the map, I have to acknowledge the assistance I received from Mr. Powell, the surveyor of Blount, who traced for me the head of Murphree's Valley, and sent me specimens of the rocks. Dr. Lewis, of Blount, also assisted me in delineating the valleys in that county.

My thanks are due in a special manner to those who promoted directly the objects of the survey.

Mr. O. S. Olmsted, has on numerous occasions rendered me efficient assistance.

I am also under many obligations for the communication of

fossils illustrative of the geology of the State. To Dr. Newman, of Huntsville, and Mr. Charles Jones, of Bolivar, I am indebted for fossils of the limestone of that region.

I owe to the politeness of Mrs. Bagshaw, of Greensborough, a fine suite of cretaceous fossils from the vicinity. I am under similar obligations to Dr. Withers, of Greene county. Dr. Bonner, of Dallas, has sent me cretaceous fossils of great interest. Fossils from the cretaceous formation of Pickens, have been kindly presented by Dr. Adams, of that county.

S. S. Sherman, President of Howard College, Marion, has favored me by the transmission of most valuable organic remains from the cretaceous rocks.

To Mr. John Coate, of Clarke, I am under special obligation for his care in collecting for me fossils from the white limestone. Mr. Chambers, of the same county, has also kindly aided me. My thanks are due to Capt. Baria, of Choctaw, for similar favors.

For a fine collection of the Echinoderms, and other characteristic fossils of the white limestone of Cedar creek, liberally presented by Mr. Forbes, I have to return my thanks.

I trust that in the progress of the survey, and in future reports, the result of such kind aid in the elucidation of the geology of the State, will be more apparent, than it was possible to make it in the present preliminary report.

It would be difficult, without the danger of appearing invidious, to attempt to mention the numerous instances in which I received other important assistance, as it would be impossible to enumerate the acts of kindness and hospitality received from our citizens generally. For all such kindness, I can only present my grateful acknowledgments.

M. TUOMEY.

UNIVERSITY OF ALABAMA,
Dec. 20, 1849.

INTRODUCTION.

In reports of a scientific character, presented to our Legislatures, but really intended to be read by the people, there will be more or less difficulty in comprehending their true bearing, in proportion as the subjects to which they relate enter into our system of popular education; for, however the subjects may be divested of technicalities, it is scarcely possible, if even it were desirable, to present the naked facts of a science apart from, at least, some of its leading principles. Geology has recently excited much interest, and has been introduced as a subject of study in the better class of schools; to this end, the various geological reports presented to the State Legislatures have greatly contributed, besides effecting what is generally considered their legitimate object, namely, the bringing to light of the economical resources of the country. There are yet, however, many otherwise intelligent persons, who have paid but little attention to this science, and who imagine that the rocks composing the globe upon which we live, lie upon each other without any fixed order of succession; that minerals and ores are scattered through them indiscriminately, occurring "in one place as well as another," and that they are to be searched out accordingly. And hence the loss of time, and disappointment, arising from the unsuccessful search for valuable minerals, where they cannot possibly occur. Not knowing that different minerals are associated with particular kinds of rocks, and are never found elsewhere, unskilful persons are constantly searching for them in the wrong places. A spot was pointed out on the Warrior, among the coal-measures, that presented "beautiful gravel," and indeed all that appertained to a "rich and valuable gold mine," excepting the gold; the discovery of a gold mine in Clarke county has been reported in the newspapers; and still more recently, much interest has been excited in Cherokee county by the discovery of what was supposed to be a silver mine, among the coal-measures of the Lookout Mountain. I could point out innumerable

instances of this sort, where the slightest knowledge of geological science would have shown the absurdity of looking for the precious metals in such places. It is plain, that the inconvenience arising from this state of things, can only be obviated by giving the people opportunities of acquiring correct views of the science that relates to the structure of rocks, and to the manner in which minerals are distributed amongst them. It is for this reason, as well as to prevent the frequent explanations, that would otherwise be necessary, that the reports of our geologists are so frequently prefaced by an introduction to the science of geology; and for a like reason, I have thought that it might be useful to prefix a very brief outline of the subject. Should it induce any of the readers of this report to consult works expressly devoted to the elucidation of the principles of the science, its design will be fully accomplished.

Geology.

The science of Geology is mainly derived from the recorded results of accurate observations, made by competent persons, in all parts of the world. It examines into the mineral composition of rocks, their structure, order of succession, and distribution on the earth's surface. It points out the connection between rocks and soils, and is thus at the very foundation of agricultural science. A knowledge of the structure of rocks, presents the miner with the only reliable guide in his search for useful minerals; whilst both the architect and engineer may derive important aids from this science.

This is the mere utilitarian view of the science; but Geology has higher, nobler aims than these: it enables us to contemplate, through a succession of ages, the effects of those changeless laws impressed upon matter by the Creator, and which are still modifying the earth's surface. It traces, step by step, the progress of life upon the globe, shows us that whole races of animated beings once lived, and passed out of existence, to be succeeded by others that, in like manner, after fulfilling their destiny became extinct, and were followed by still other races; it enables us to perceive, in all these revolutions, design, goodness, wisdom and power; in a word: "Evidences like these make up a history of a high and ancient order, unfolding re-

cords of the operations of the Almighty Author of the Universe, written by the finger of God himself, upon the foundations of the everlasting hills."

Structure of the Earth.

Our knowledge of the structure of the earth can, for obvious causes, extend directly only to a limited depth below the surface; the portion thus coming within our knowledge, is called the earth's crust. This crust, so far as we yet know, is made up of about sixteen simple substances, which distribute themselves under three groups:

Non-metallic substances.	1. Oxygen, 2. Hydrogen, 3. Nitrogen, 4. Carbon, 5. Sulphur, 6. Chlorine, 7. Fluorine, 8. Phosphorus.
Metallic bases of the earths and alkalies.	1. Silicium, 2. Aluminum, 3. Potassium, 4. Sodium, 5. Magnesium, 6. Calcium.
Metals.	1. Iron, 2. Manganese.

These, by their combination, produce other substances; for instance, oxygen combines with the non-metallic substances, and forms water, acids, &c.; and with the bases of the earths and alkalies, and forms such substances as silica, alumina, potash, soda, magnesia, and lime. These again unite with each other, and give rise to a few minerals, which, by their aggregation, make up rocks. The following table exhibits the name and composition of those minerals, which, in geological language, are called simple, to distinguish them from rocks which are aggregates:

Simple minerals.	*Composition.*
1. Quartz	Silica.
2. Felspar	Silica, alumina, iron, lime, potash or soda.
3. Mica	Silica, alumina, potash, iron, lime.
4. Talc	Silica, magnesia, iron, alumina.
5. Hornblende	Silica, magnesia, lime, alumina, iron.
6. Argillite	Silica, alumina, iron, lime.
7. Chlorite	Silica, alumina, magnesia, iron.
8. Limestone	Carbonic acid and lime.
9. Gypsum	Sulphuric acid and lime.

The principal rocks that make up what is called the earth's crust, are—1. Granite; 2. Trap rock; 3. Gneiss; 4. Hornblende slate; 5. Mica slate; 6. Talcose slate; 7. Chlorite slate; 8. Clay slate; 9. Limestone; 10. Sandstone; 11. Conglomerate; 12. Loose superficial beds, composed of clay, sand, boulders, &c.

1. *Granite*—Is a crystalline rock, made up of the three minerals, quartz, felspar, and mica, each of which may readily be distinguished throughout the rock. It presents some varieties arising principally from the relative proportions of its constituent minerals: such as quartzose, micaceous, and felspathic granite, in which quartz, mica, or felspar abounds. Sometimes hornblende is substituted for the felspar, when the rock is called *sienite*. As a building material, where great strength and durability are required, few rocks equal granite. In the selection of it for this purpose, care should be taken to reject those blocks in which the felspar has lost its lustre, which marks the incipient stages of disintegration.

2. *Trap rock.*—This is a compact, hard rock, of a dark, or greenish color, and dull lustre. It is composed principally of hornblende.

3. *Gneiss*—Has the same composition as granite, and differs from it only in being stratified. The mica is disposed in thin layers, between the other materials, and hence the rock splits readily along these planes. It occurs near Wetumpka. Like granite, it makes an excellent building stone, but should be laid on its bedding planes; a rule which applies to all the stratified rocks, and which is frequently neglected by our masons.

2

4. *Hornblende slate.*—This rock resembles gneiss, but has the mica replaced by hornblende. It may be mistaken for gneiss or mica slate, in which the mica is black, but mica being highly fissile, can easily be determined.

5. *Mica slate.*—This is a schistose, or slaty rock, in which mica abounds. It passes into gneiss, from which it can only be distinguished by the prevalence of the mica.

6. *Talcose slate.*—This rock is known by its greasy or soapy touch. In general appearance, it resembles mica slate; but but the want of elasticity in the talc is sufficient to distinguish it from the latter. It makes a pretty good fire-stone for ordinary purposes, such as the lining of lime-kilns, &c. It occurs in Talladega in great abundance, and contains the gold mines and quarries of marble of that county.

7. *Chlorite slate.*—Like the preceding, this rock has a soapy touch, but is always of a decided green.

8. *Clay slate.*—This rock consists, for the most part, of clay and silica; it has a slaty structure, and is frequently highly fissile. The shale of the coal-measures is a variety of this rock. The common cyphering slate is a good example.

9. *Limestone.*—This well known rock is composed of carbonic acid and lime. It can always be detected by its effervescence, on the application of an acid. Magnesian limestone, in addition to the lime, contains magnesia, and effervesces more slowly than the common varieties.

It possesses, in a high degree, all the good qualities of an excellent building material. When sufficiently compact to take a polish, it is called marble. Our white, black, and variegated marbles, are only compact limestones.

10. *Sandstone*—As the name implies, is composed of grains of sand, held together by a silicious or argillaceous cement. Scales of mica, and a considerable amount of argillaceous matter, are often present. The less argillaceous varieties make the best building materials.

11. *Conglomerate.*—Like sandstone, this rock is composed of particles of other rocks or minerals, cemented in a like manner. The fragments, however, are large, and generally rounded and water-worn. This variety is called pudding-stone. When the fragments are angular, the rock takes the name of

breccia. Sometimes the fragments are calcareous, but more frequently they are silicious.

12. *Loose superficial materials.*—These make up an important series in some regions. They in general consist of the ruins of other rocks, often transported to a distance. The accumulations on the banks of rivers belong to these.

Groups or classes of Rocks.

The rocks just described, when viewed in masses, arrange themselves under two great groups, depending on their structure: the first consists of the *unstratified rocks,* also called primary. They are distinguished by their crystalline structure, and by the absence of all marks of stratification. They are again conveniently sub-divided into granitic, and trap rocks.

Granite is the type of the first variety; and so far as man has yet penetrated, it is found to be the lowest rock. It appears, therefore, as the foundation upon which all the others rest. It is, nevertheless, often found resting upon the others, and protruded through them; so that granite is not, in all cases, the oldest rock, as the name primary would imply. Granite often occupies a considerable extent of the surface of the earth, and sometimes rises into mountains.

The basaltic rocks are less extensive, occupying, for the most part, the rents and cracks in other rocks: they also appear spread out on the surface as if by overflowing, from the fissures, through which they seem to have been injected from below in a molten state.

The effects produced upon adjacent substances by the crystalline rocks, are in every way so similar to what would result from contact with intensely heated matter, that the name of "igneous rocks" has been applied to them. Bituminous coal is found converted into anthracite, by the loss of the bitumen, which has been driven off by the heat. Chalk has been converted into crystalline limestone, and rocks are found altered, when in contact with them, in such a manner as to render it impossible to account for these effects on any other supposition than that the crystalline rocks once existed in a state of fusion.

That there is at present some source of heat below, is evident from the increase of temperature as we descend beneath

the surface, the existence of thermal springs and volcanoes. Whether these are the effects of the action of an intensely heated central mass, or of immense lakes of molten matter, we need not stop here to consider. It is supposed that it is the oscillations produced by the disturbance of this liquid mass that produce earthquakes, with all their terrible consequences.

Stratified Rocks.

These are readily distinguished by the layers or beds in which they are arranged, and which are supposed to result from deposition in water; at all events, they present every appearance of matter once held in suspension in water, and afterwards deposited. The layers are of various thickness, and they split along the lines of stratification, or bedding planes, precisely as sedimentary matter does. These rocks admit of a natural division, depending upon the absence or presence of organic remains; those containing no remains of plants or animals, are called *non-fossiliferous*, and those in which such remains are found, have received the name of *fossiliferous rocks.*

Metamorphic Rocks.

The non-fossiliferous rocks differ very materially from recent sedimentary rocks; they are more crystalline in structure; they appear altered from their original condition, and hence the name metamorphic has been applied to them.

The oldest or lowest of these is gneiss. As it is composed of the same constituents as granite, it is highly probable that it is made up of the ruins of that rock. It is an important rock, and forms whole mountain ranges. The ores found in gneiss, are those of silver, copper, lead, zinc, tin, bismuth, iron, antimony and nickel.

Mica slate.—Next above the gneiss we have mica slate, into which gneiss often passes. Some varieties are used as whetstones, and the ores of tin, iron, manganese, lead, zinc and copper occur in it.

Hornblende slate often alternates with this rock and with gneiss.

Talcose slate is generally found overlying these rocks; they

pass indeed by insensible gradations into each other; a variety, intermediate between this and mica slate, has received the name of talco-micaceous slate. This is the great gold-bearing rock of the United States; besides gold, ores of iron, copper, manganese, lead and zinc, are found in this rock.

Clay slate is generally the highest in this series. It is an important metaliferous rock, containing ores of iron, copper, tin, and sometimes gold.

The absence of every vestige of organic remains from the metamorphic rocks, can only be accounted for on the supposition, that when they were formed, life had not yet been introduced on our globe; for otherwise, it is difficult to conceive how every trace of it should have been so completely obliterated.

Fossiliferous Rocks.

There can be but little difficulty in understanding how vast accumulations of sedimentary matter may be deposited: every shower of rain is removing portions of the soil and superficial beds, which are carried down by the streams and rivers to the sea. This downward tendency of the solid materials constituting the dry land of our planet, is but one of the effects of those great immutable laws impressed upon matter. Although, in general, such effects are slow, and scarcely perceptible, yet they sometimes, in the lapse of a few years, produce changes that affect the physical features of a country.

The verge of the plain, on the river side, upon which Tuskaloosa stands has, within the memory of men now living, been scooped by the rains, into ravines of enormous extent, that give a pretty correct view of the formation of hills and valleys by denudation. It will be shown farther on, that these materials have been brought from the upper part of the State, so that they have but resumed their onward journey to the ocean.

The phenomena presented by the sedimentary rock can be explained by reference to what is now in actual progress. It is well known that the size of the materials transported by water is an index to its velocity; we find frequent alternations in the strata under consideration, of coarse and fine materials, varying between large paving stones and fine clay. The lam-

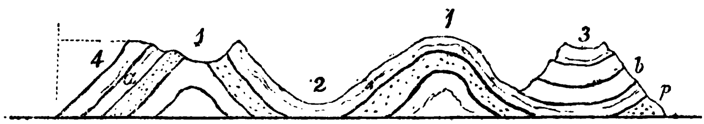
ination of the beds, the ripple-marks left on their surface, and in every other respect, they bear so striking an analogy to the deposits that are now in progress, that they must be referred to like causes. The materials transported by the rivers, are spread out over the bottom of the sea, and in process of time, converted into solid rock. This conversion of loose materials into compact masses, may be seen along our shores, where the consolidation takes place by the infiltration of iron, lime, argillaceous or silicious matter. If the sea contain any living beings, they will be entombed in this sedimentary matter, and their remains will be imbedded, and preserved in the rocks thus formed. If the deposits take place in rivers or lakes, the enclosed remains will be those of fresh water animals and plants; if in the estuary of a river, they will be those that inhabit brackish water; and if in the sea, they will be altogether marine. It is in this way that the rocks present complete records of the former history of our globe, with all the changes that it has undergone; the introduction of classes of animals and plants upon it, their final extinction, and very often the conditions of their existence, become known to us. If the accumulations thus formed, after consolidation, be lifted up by some force from below, the effect will, of course, be the formation of dry land, and this accounts for the remains of marine animals being found on the tops of mountains.

That rocks were thus uplifted, we have the most abundant evidence—evidence, too, that any one may observe for himself. In most cases, the rocks were not lifted up bodily, but the lifting force acted along lines, and in directions that may be traced for hundreds of miles. One of these lines may be seen in Jones's Valley, where the limestones are pushed up into a vertical position, while the coal-measures on the Cahawba and Warrior incline towards the east and west. This tilting up of the rocks, besides the scientific interest connected with the effects of a force so enormous, as to be capable of lifting strata of rocks miles in thickness, has also a highly important practical bearing. But for it, our knowledge of the structure of the earth's crust would be far more limited than it is. To express the effects produced by this force, we have a few terms that are technical to geology. The line along which the force acted, and towards which the strata lean, is called the *anticlinal line*

or axis; and the direction of the edges of the tilted rocks, taken along a horizontal line, is called their strike; it corresponds with what the miners call "level course." The *dip* expresses the angle which the uplifted rocks make with the horizon; it varies between vertical and horizontal, and is always at right angles with the strike. When two parallel uplifts have taken place, the line from which the strata rise on each side, is called the *synclinal* axis.

The following diagram will explain these terms:

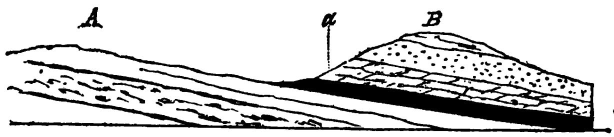
FIG. 1.



1, 1—Anticlinal axes. 2, 3—Sinclinal axes; generally, synclinal axes are confined to valleys, but they often occur as represented at 3, on the summits of mountains. 4—Represents the dip, or angle which the stratum *a* makes with the horizon. In the case represented, the dip is 45°. When the edges of the strata come to the surface, they are said to *outcrop*, as at *b*, *p*.

Numerous examples could be presented where a knowledge of these simple facts would have proved highly useful; but a single illustration must suffice. The inclination of the beds of coal in the Warrior coal-field is very slight, and hence they are found out-cropping in numerous places, in ravines, banks of streams, &c. In taking up, or "entering" the public land, persons always prefer land on which coal appears on the surface, and it but rarely happens that they purchase any other, at least, on account of the coal. Now, I know from actual observation, that where the coal is explored and worked, that many who have purchased land in this way, will be utterly disappointed. But, a single diagram will fully explain this:

FIG. 2.



Let *a* represent the boundary line between the tracts of land *A* and *B*, and the *black line* a bed of coal out-cropping on the tract *A*. Now, it is obvious, that although no coal is seen on *B*, that, nevertheless, the principal part of the bed belongs to that tract.

Coal lands are sometimes purchased on the Warrior, where the coal can only be raised, owing to the direction of the dip, at very great expense. It is plain, indeed, that simple as this knowledge is, no mining operations can be conducted with any chances of success without it.

From what has been said of the manner in which the remains of animals and plants are entombed in rocks, it must appear that they present a means of classification far more certain than any that has ever been proposed.

The term *fauna* is applied to the living beings, taken collectively, that inhabit a country, as the word *flora* is used to designate its plants. Every one knows that there are animals and plants peculiar to different countries, and even to different parts of the same country. Tropical plants are not to be mistaken for those of any other region; and even where the contrast of climate is less striking, the range of certain plants is limited. Our long-leaved pine scarcely crosses the Roanoke, and the palmetto does not extend to the Cape Fear.

There are shell-fishes living on the coast of New England, that are not found farther south, whilst many southern forms do not exist at the north; and scarcely any of either are found on the other side of the Atlantic.

In America, we have not the elephant, rhinoceros, the camel, or the lion; but we have the bison, the elk, and the bear. Now, when the remains of ancient floras and faunas embedded in the solid rock, by a process already explained,

are brought to light, it is easy to see, to what extent, and with what certainty, they teach the past history of our globe.

Organic Remains.

It appears from the investigations of geologists, that the oldest *flora* and *fauna* consisted altogether of the inhabitants of the ocean, and that even these were of the lowest types, such as sea-weeds, shell-fish, tribolites, (animals related to crabs,) and cartilaginous fishes. It appears further, that these types characterised this period all over the world; that at the end of this period, they were blotted out of existence, and succeeded by other types, which were destined to give place to others of a higher order in the scale of being. From the investigations of geologists, it also appears that this succession of organic forms was adapted to a corresponding progression in the state of the earth's surface, so that every where, among fossil groups, of successive formations, marks of adaptation to pre-existing conditions may be observed. Crustaceous animals follow the sea-weeds upon which they fed; the voracious sauroid fishes are introduced after a supply of food was prepared in the existence of other animals. Huge reptiles appeared still later, that preyed upon these. Birds came into existence after the appearance of land, as indicated by the presence of land plants. Insects precede the insectivora. Herbivorous animals appear still later, where plants were, in number and kinds, sufficient to afford proper food, and are followed by carnivorous animals, which prey upon them, and last of all, man appears.

A classification of rocks, based upon the distribution of organic remains, has been adopted by geologists, and is presented in the following table:

TABLE,

Showing the order of superposition of the Fossiliferous and other Rocks.

RECENT PERIOD, OR POST PLIOCENE.

Systems, Formations, and Groups.	Localities of characteristic deposits in America.	European Equivalents and Localities.
Alluvium,	Superficial deposits.	Found in all countries.
Stratified beds of clay and sand, containing the remains of extinct mammals and recent shells.	Atlantic coast.	
Drift, or Diluvium.	Northern States.	Northern Europe.

TERTIARY PERIOD.

Newer Tertiary, or Pliocene.	South Carolina.	Till of the Clide valley, Norwich crag. Subappenine beds.
Middle Tertiary, or Miocene.	Maryland, Virginia, North Carolina.	Red crag, Basin of the Rhine, Molasse of Switzerland.
Older Tertiary, or Eocene.	Maryland, Virginia, South Carolina, Alabama.	London clay, Paris Basin, Auvergne.

NEWER SECONDARY PERIOD.

Cretaceous System.		
Gault.	New Jersey, South Carolina, Alabama.	Maestricht beds.
Upper chalk, (with flints.)		
Lower chalk, (wtthout flints.)		Craie tufau.
Chalk Marl.		
Upper Greensand.		
Lower Greensand.		Neocomien.

MIDDLE SECONDARY PERIOD.

Wealden Formation.		
Weald clay.		Portland.
Purbeck beds.		Surrey, Kent & Sussex.
Oolitic System.		
Portland stone.		Oxford, Bath.
Kimmeridge clay.		Jura chain.
Forest marble.		
Great Oolite.		
Inferior Oolite.	Virginia?	
Lias Group.		
Upper Lias.		Lyme regis.
Lower Lias limestone,		Whitby.

OLDER SECONDARY PERIOD.

Systems, Formations, and Groups.	Localities of characteristic deposits in America.	European Equivalents and Localities.
Upper New Red, or Triassic System.		Keuper.
Saliferous, or New Red Sandstone.	Massachusetts, Connecticut,	Muschelkalk. Bunter sandstone.
Red Sandstones and Conglomerates.	Virginia, N. and S. Carolina.	(Gres bigarre.)

NEWER PALÆOZOIC PERIOD.

Magnesian Limestone, or Permian System.		Permia, Russia, Zechstein.
Magnesian Limestone.		
Lower New Red.		Rothe-todte-liegende.
Carboniferous System.		
Coal Measures.	Pennsylvania, Virginia,	Coal Measures of the
Millstone grit.	Ohio, Alabama.	North of England.
Carboniferous, or Mountain Limestone.		
Lower Carboniferous Shales.		

MIDDLE PALÆOZOIC PERIOD.

Devonian System, or Old Red Sandstone.	New York, Pennsylvania, Ohio, Michigan.	
Yellow quartzose sandstone.		Devonshire.
Flagstones.		
Limestones.		
Conglomerates.		

OLDER PALÆOZOIC PERIOD.

New York System.

Upper Silurian Rocks.		
Chemung Group.		
Genesee Slate.	New York and Western States, Alabama.	Wales.
Marcellus Slate.		
Ludlow and Wenlock Series.		Russia.
Hilderberg Series.		
Lower Silurian Rocks.		
Caradoc Sandstone.	Vermont, New York.	
Llandeilo Flags.		Wales.
Champlain Division.		Scandinavia.

PRIMARY AND METAMORPHIC ROCKS.

Metamorphic Rocks.	Atlantic States.	Scotland and other countries.
Granitic Rocks.	"	"

Silurian Rocks.—The lowest, and consequently the oldest, of these groups, has received the name of Silurian rocks, because they occupy the country once inhabited by the ancient Britons, who were called Silures. Local names of this sort are useful, because they refer to localities where the rocks so designated occur in their most characteristic form, so that no doubt can remain as to the meaning of the author, who makes use of such names.

The Silurian rocks extend from New York to Alabama. They are composed of sandstones, conglomerates and limestones, and are characterised by the remains of sea-weeds, corals, shells, trilobites, and fishes; the latter being the most highly organised forms that they contain. In the upper Silurian rocks, remains of plants appear for the first time. The great north-western lead mines occur in these rocks. Silver, copper, and excellent beds of iron ore, are also found in them.

Old Red Sandstone.—The rocks of this system consist of slates, limestones, conglomerates, and sandstones of a brick-red color. They are developed in New York, Pennsylvania, and Virginia. Corals were abundant during the deposition of these rocks. The molluscous animals were of higher types; but the trilobites had become rare. Fishes of the most singular forms made their appearance, and in this country, reptiles have left their remains for the first time in these rocks.

Carboniferous System.—This system consists of a vast series of beds of limestone, upon which the millstone grit reposes. This last rock underlies the coal-measures composed of beds of shale, sandstone, and coal.

There are two fossils in the carboniferous limestone of Alabama, that serve to distinguish it from the Silurian limestones; these are a screw-shaped coral, called *Fenestella Archimedes*, and a species of pentremites. The coal-measures are every where characterised by the great abundance of fossil plants, which are found principally in the shale that overlies the coal, where they appear in a state of wonderful preservation. The stems of very large plants occur both in the shale and overlying sandstone, that belong to the genera *Sigillaria*, *Calamites*, and *Lepidodendron*. Beneath the coal there is generally a bed, called by the miners under-clay, in which a peculiar fossil called Stigmaria, is quite abundant.

The basin-shaped depressions in which coal is found are remarkable, but are not universal, in Alabama, for instance, they are long and trough-shaped, resembling shallow valleys, which are the result of the uplifting forces that have elevated the edges of the coal-measures.

The flora of the carboniferous system is characteristic of a damp, warm climate, such as at present is peculiar to the islands within the tropics, for no where else do we find the luxuriant vegetation of the coal formation.

For speculations upon the causes that have so changed the climate of various portions of the earth's surface, and upon the extinction of species, I must refer the reader to the full treatises upon this subject.

It is now universally admitted, that coal is of vegetable origin; that it is derived from vast accumulations of wood, peat, and other vegetable matter, carbonized under great pressure. Whenever this carbonization occurred under circumstances that prevented the escape of the gases, the result is bituminous coal; but where they could escape, anthracite is produced. Thus, along the anticlinal line of the Alleghany Mountains, where the strata have been fractured, anthracite occurs; and as we recede from that line, the coal becomes more and more bituminous. Anthracite is also produced in the vicinity of trap dykes. The structure of wood may be detected in coal by means of the microscope; and charcoal is of common occurrence in the coal of Alabama. The state of preservation of the plants associated with the coal, as well as the fact that many of them are found standing erect, renders it probable that they grew as we find them, and that the whole mass was accumulated on the spot where the coal is found. Even in our own climate, the luxuriant swamps along the coast enable us to understand how this could happen. If we suppose a subsidence to take place, and the whole to be covered by sedimentary deposits to a great depth, and heat applied below, it is easy to conceive how the compact carbonaceous substance, coal, would be produced, where nothing can escape.

Besides the great number of plants found in the carboniferous rocks, they contain corals, the remains of mollusks in great number, and voracious fishes of an extraordinary character.

Besides the building materials afforded by these rocks, the

carboniferous limestone is in some countries highly metalliferous rock, containing lead, silver, copper and zinc.

The coal measures, besides coal, contain clay, iron-stone, or carbonate of iron, the ore used so extensively in England.

New Red Sandstone.—This system is composed of strata of sandstone of a red color; it extends from Connecticut to South Carolina, where it terminates. Organic remains are not abundant. The most important are those of fishes; the last of the type with unequally lobed tails. The appearance of birds upon our globe is first indicated during the deposition of these rocks, as appears from the tracks left on the sandstone of the Connecticut valley. Some peculiar reptiles are also found in this system.

Lias and Oolitic Systems.—These are included by the geologists of continental Europe under the name of *Jurassic system.* The rocks of the Lias are composed of beds of shaly, and argillaceous limestones, marl and clay. They are remarkable for the great beauty and fine preservation of their fossils. It is here that the great reptiles Ichthyosaurus and Plesiosaurus make their appearance on the stage of existence. The first mammal is also found here.

Wealden group.—This interesting fresh water formation is not found in this country. It is composed, for the most part, of beds of gravel, sand and clay, transported by a river. Besides fresh water shells, the organic remains include the bones of a gigantic herbivorous reptile, the Iquanodon.

Cretaceous group.—Next above these, we have the remarkable rocks that include the chalk of England, from which the name is derived. The prairies of Alabama and Mississippi belong to this group. The fossils are abundant; among which chambered shells of the genera Nautilus and Ammonites are conspicuous. The most remarkable fossil consists of bones of a huge reptile, related to the Mososaurus. The Ammonite disappears with these rocks, to be found no more. Ores of iron, gypsum, limestone, marl, and potter's clay, are the only mineral substances of economical value to be looked for among these and the following rocks, excepting the alluvium in which ores are sometimes found, that have been transported from other rocks.

Tertiary period.—The rocks of this period consist, in general,

of loose sands, gravel, clay, limestones and marl. Although widely distributed, they are not often found in continuous beds, but in patches, on the surface of the underlying rocks.

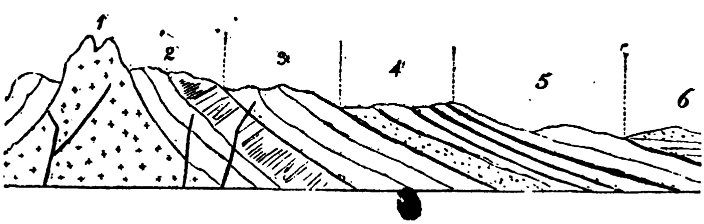
Sir Charles Lyell has proposed a classification of the Tertiary rocks, founded on the relative proportion of recent and extinct species of shells that they contain. The oldest deposits he named "eocene," a word signifying the dawn of the present order of things. The eocene contains in Europe only about 3½ per cent. of recent species. To the middle portion of the tertiary, he gave the name of "miocene," which signifies the preponderance of extinct species over the recent; and to the upper beds of the series, he gave the name of "pliocene," in reference to the greater number of recent species found in them. The miocene of Europe contains about 17 per cent. of recent species, and the pliocene from 35 to 50 per cent. The "post pliocene" beds are characterized by the remains of animals and plants belonging to the present period.

The term "drift" is applied to certain beds of loose gravel, sand and clay, containing large water-worn and angular blocks. These beds are not known at the south, but cover a considerable extent of country in the north of Europe and America.

The "alluvium" includes the deposits that are at present taking place, in the estuaries and on the banks of rivers; of course they contain the remains of works of art, as they are contemporaneous with man's existence on the earth.

The following wood cut will convey a clear idea of the relative position of the rocks thus briefly described:

FIG. 3.



1—Granite. 2—Metamorphic rocks. 3—Silurian system. 4—Carboniferous system, beds of coal, &c. 5—Cretaceous rocks. 6—Tertiary beds. The dark irregular lines intersecting the strata in a vertical direction, represent trap dikes.

CONTENTS.

REPORT

ON THE

GEOLOGY OF ALABAMA.

CHAP. I.

Order of super-position of the Rocks of Alabama—Extent—Geological Structure — Talcose Slate — Gold — Marble—Limestone—Plumbago.

INSTEAD of dividing the State according to its geographical boundaries, and describing each division separately, as is often done in Geological Reports, I have found it more convenient to describe the Rocks of Alabama in accordance with their geological position, and to follow out each formation in connexion, wherever it may be found.

The following table exhibits the order of succession of the rocks of the State:

6. Tertiary System.
5. Cretaceous System.
4. Carboniferous System { Coal Measures. Millstone Grit. Carboniferous Limestone.
3. Silurian System.
2. Metamorphic System.
1. Primary System.

1. Primary and Metamorphic Rocks.

In Talladega, a crystalline or true granite is said to occur, and I have therefore given it a place among the rocks of the State, although I have not seen it. All the rocks that I have seen, called by this name, are gneiss, and belong to the overlying system.

2. Metamorphic Rocks.

Extent.—These rocks occupy a considerable area of that part of South-Carolina, and Georgia, above the first or lowest falls of the rivers. They enter Alabama from the upper corner of Carroll county, and have their N. W. boundary passing through the S. E. corner of Benton county, from thence it passes in a S. W. direction, three or four miles east of the town of Talladega; crossing the Coosa above Fort Williams, it runs through the lower corner of Autauga county. All that part of the State, east of this line, is occupied by the Metamorphic rocks. Towards the S. E. they lose themselves beneath beds of pebbles, sand, and clay, of a more recent formation. The entire county of Randolph, a portion of Benton, Talladega, Chambers, Tallapoosa, Shelby, Coosa, and Autauga counties, are covered by these rocks. In the bed of the Coosa they are laid bare, as low as Wetumpka, which is the most southern exposure of this important group of rocks in the United States.

Wetumpka, therefore, is the southern extremity of a line inscribed on the map of the United States, with extraordinory accuracy, many years ago, by McCullough, as the boundary of the primary region. It marks, be-

sides, an important physical feature of the country; for, commencing on the Delaware at Trenton, it crosses the head of navigation of all the important rivers of the Atlantic slope—the Delaware at Trenton, the Potomac at Washington, James river at Richmond, the Appomatox at Petersburg, the Roanoke at Halifax, the Pedee at Cheraw, the Wateree at Camden, the Congaree at Columbia, the Savannah at Augusta, the Chattahoochee at Columbus, and the Coosa at Wetumpka.

The rivers, after passing the barrier presented by these rocks, meet with but little resistance from the less consolidated beds of the cretaceous and tertiary formations that border the Atlantic, and Gulf of Mexico, below the falls of the rivers, from New-Jersey to Texas.

Structure. Of this important formation, I only examined the eastern portion, beginning 4 miles S E of the town of Talladega, at the marble quarry. At this point, heavy strata of talcose slate rise into prominent ridges, extending from N. E. to S. W. The slates are much contorted, and dip to the S. E. at an angle of about 40°.

A good section of these rocks may be seen at Talladega creek, at Taylor's mill; they are exposed on both banks of the creek, and are, for the most part, of a grey color, occasionally passing into black; they are hard and silicious, and contain thin seams of quartz, and nodules and crystals of iron pyrites.

About three miles north of Syllacogga they cross the public road; and at this locality enclose beds of limestone. Towards the west, the sharp well defined outline of the hills composed of talcose and mica slates, are seen to the south of Talladega creek.

These slates have been explored for gold on the last mentioned creek, but I believe to no great extent, nor with any profit. The gold-bearing rocks, are found to extend from Randolph to Autauga, but, so far as I have seen them, they differ very materially from the productive rocks of North and South-Carolina: they present less tendency to disintegration, are less silicious and feruginous, and are but seldom intersected by quartz veins—features that strike the least observant, in the gold region of the States just mentioned. As I have seen only the verge of this formation, of course I can say nothing of Randolph, Tallapoosa, and other places, where the indications may be more promising. It is not a little striking to observe how frequently these slates are accompanied by beds of water-worn pebbles, that seem to have lodged in the depressions between the hills, and which in North-Carolina, South-Carolina, and Georgia, are auriferous, constituting the deposit mines of these States. It is highly probable that beds of grey, or magnetic, iron ore, will be found in this region.

A small specimen of pure plumbago was shown to me, which was found on the Hillabee, and another specimen, said to be plumbago, from Hatchet creek. In the latter, I recognized a substance, brought to Tuskaloosa, and sold for that mineral; but, as it was always ground, I was unable to say precisely what it was. I now find that it is a soft black talcose slate, free from grit; it has, of course, a soapy touch, like plumbago, and may be a good substitute, to lessen the friction of wheels and machinery; but it contains not a particle of plumbago, or black lead, as it is usually called.

The most interesting rock of this series is a white and grey crystalline, limestone or marble, which underlies the slates, along their western edge. Marble is associated with the same rocks in Spartanburg, S. C., and the counties of Habersham and Hall, Georgia.

About four miles from the town of Talladega, along the base of a little range of hills forming the valley of Talladega creek, the marble comes to the surface, where a quarry has been opened for its exploration. A part is white and finely crystalline, whilst other beds are hard, compact, and fine grained. As this marble is stratified, the colors run in layers, corresponding with the bedding planes of the rock, and hence the striped appearance of the slabs, when dressed. Seams of pure white, fifteen to twenty inches thick, are not uncommon; but the mass of this rock is more or less colored, and scales, and even layers of talc are found interstratified with it. Cherty portions are also found, which, although scarcely distinguishable from the rest, the silicious particles being intimately blended, with the lime, are very hard and troublesome.

The value of this, and the adjoining quarries, is much impaired by the cracks and joints that intersect them. But I observed that they are sometimes confined to certain beds, and do not extend to the overlying ones, and therefore a careful exploration may bring to light beds not thus broken up. This is rendered more probable, by the great thickness of the beds, which amounts to forty or fifty yards. The strata have a dip of 40°, but they vary greatly in this respect, being sometimes undulating, and even contorted, and thus resemble the

slates with which they are associated. There are three quarries opened within a short distance, in the same range, at natural exposures. As is generally the case where limestones occur with less destructible rocks, they have suffered much from denudation, and are consequently but little elevated above the surface. I think, however, that there can be no doubt that marble may be found at numerous intermediate points between these quarries, although it may be below the surface. On Talladega creek there is quite a respectable establishment, owned by Mr. Taylor, for working marble for monuments, and tablets for graves, which appear to be the sole use made of this valuable rock. The grey or lead colored varieties are ornamental and take a fine polish. At the lower quarry on the creek, the marble passes into a very distinctly stratified common bluish limestone, cut by joints, which breaks up into large tablets. This rock is admirably fitted for architectural purposes. The finest quarries are at the southern extremity of the range, near Syllacogga. The most important of these, is that opened by Dr. Gant, about ten miles west of the Coosa. The difference in favor of this locality consists, not more in the quality of the marble, than in the regularity of the stratification of the beds and freedom from joints.

The rock does not rise much above the surface, at the point where the quarry is opened, and is every where else covered by beds of clay and loam. The strike is N. E. and S. W., which is, of course, the direction a continuation of the quarry must take. The dip is 45°, and a greater proportion of the rock at this place is

white, than at the other quarries. I saw masses ten feet long, four feet wide, and thirty inches thick, almost a pure white, recently quarried. The strata are, however, in general, interstratified with flakes of talc; the seams in which this mineral is found mixed with the rock, vary in thickness, from one inch to a foot, or more, and as it is, as usual, disposed along the bedding planes, it facilitates the quarrying very materially, by disposing the rock to split in that direction. When the white seams are not thick, the rock can be sawed so that the slabs may present one or even two white surfaces; so very regular is the stratification.

The size of the blocks that may be procured here, seems to be limited only by the means of removing them from the quarry. Some of the pure white marbles are finely lamellar or crystalline, and both in texture and color, compare well with the finest Italian marble. The simple statement of the fact, that blocks of white marble, thirty inches in thickness, and the other dimensions in useful proportion, may be obtained at this quarry, is sufficient to show its great importance. The value of these quarries would soon exhibit itself, if there existed but a cheap mode of conveyance to any navigable point on the river; but it is a fact that should be known to our citizens, and one that places in a clear point of view the state of our ordinary means of transportation, that although this quarry is situated within ten miles of such a river as the Coosa, marble may be brought from the North to Mobile, or even Montgomery, nearly, if not altogether, as cheap as from this point.

It is sufficiently obvious, that the industrial resources of Alabama can add nothing to her real wealth or prosperity, so long as this state of things continues.

I have recently received from Mr. Alexander specimens of marble from other quarries, just discovered, that are highly promising.

CHAPTER II.

SILURIAN OR OLDER FOSSILIFEROUS ROCKS.

Silurian Rocks—Extent—Mineral Composition and Structure—Red Mountain Group—Silurian Rocks of the Cahawba—Section at Pratt's Ferry—Section across Roup's Valley—Jonesborough—Elyton—Section on Five Mile Creek—St. Clair—Asheville—Section at Blount Springs.

Extent.—At Centreville, on the Cahawba, a rugged looking limestone may be seen in the bed of the river, and projecting from the banks, both above and below the bridge; this is the Southern extremity of the Silurian system in Alabama, and I believe, in the United States. To the east, these rocks spread out towards the Coosa, in Autauga and Shelby, until they cover the Metamorphic rocks in Talladega, Benton, and Cherokee counties. Along the valley of the Coosa, they make their appearance on the east, coming out from under

the carboniferous rocks of the Cahawba Valley; higher up, they are seen in the same relation to those of the Lookout Mountain, and from thence extend along the river to Rome in Georgia. They are visible about sixteen miles in a straight line S. E. of Tuskaloosa, where the waters of the Big Sandy Creek have removed the overlying loose materials, that cover the surface of this part of the State. From this they extend north almost without interruption, to the head of Murphree's valley, separating the Warrior coal field on the west, from that of the Cahawba on the east. In this direction they are confined to a series of continuous valleys, that rarely exceed seven or eight miles in breadth; they are, in truth, but one valley, although designated by different names. The southern extremity has received the name of Roup's Valley; the middle portion, which includes the towns of Jonesborough and Elyton, and extends to Village Springs, is called Jones's Valley; whilst the part between the Village Springs, and the upper extremity, where it is lost in the Racoon Mountain, has the appellation of Murphree's Valley. The direction of this valley is nearly N. E. and S. W. Although these rocks occupy anticlinal valleys, they also rise into a range of hills, which are generally known by the name of the "Red Mountains," wherever they occur; a name that is derived from a bed of red oxide of iron, that is nearly always present. And, as the mill-stone grit also rises into two ranges of parallel hills, to distinguish them from the former, they are called by the inhabitants, "Sand Mountains;" names that will enable the geologist to understand the structure of the region, when he hears the names applied; the Red Mountain always meaning the silurian rocks, and the Sand Mountain the millstane grit.

This long valley, which extends to the sources of the Warrior, and almost connects the Tennessee river with the head of navigation of that river and the Cahawba, forms also the great line of communication between the north-eastern and central portion of the State. Besides being a striking feature in its topography, it intersects the mineral region of the State, and therefore will always be a line of great interest to the engineer, as well as to the geologist.

In the valley of Blount Springs, a small patch of silurian

rocks appears, as if pushed up through the carboniferous limestones. It is from the former, that these remarkable springs rise. In the same valley, but higher up, in Marshall county, the carboniferous rocks are in some places sufficiently denuded to expose the underlying rocks. I am also informed that they come to the surface in Morgan, Lawrence, and Franklin, but as I have not examined these counties, I barely mention this fact to direct the attention of others to the subject.

Mineral composition and Geological structure.

The group of rocks under consideration, is made up of common blue limestone, white, grey, and variegated marble, magnesian limestone, both the crystalline and earthy variety, cherty limestone, hornstone, sandstone, conglomerate, iron ore, black aluminous shale, and clay slate.

It would be premature to attempt a sub-division of the silurian rocks of Alabama, by referring them to those groups adopted in New-York, where they are developed on a scale so magnificent. I shall therefore content myself by applying to our rocks the term "Red Mountain group," already known in the State, which will distinguish them from the carboniferous system with which they are intimately associated. As a mass, they are poor in organic remains, whilst the carboniferous limestone is highly fossiliferous, and the fossils of the two not being kept separate, (if indeed any were collected from the silurian rocks,) doubts have been thrown over the occurrence of any in the State, and their existence in Alabama is now demonstrated for the first time; so far as I know.

When I commenced the study of these rocks, it was with the impression that they were carboniferous, and that the mill-stone grit, and coal measures of the Warrior rested conformably upon them in Roup's Valley. This I soon found was not the case, at least, with the rocks of the Warrior, in the valley just named; and a still farther examination brought to light characteristic silurian fossils.

On the east side of the valley near the town of Elyton, I found casts of *Pentamerous oblongus*, and *Strophomena corrugata*, in the bed of iron ore which caps the mountain at that place. It is quite evident that these rocks are the equivalent of the series

of strata, designated the "Clinton group," in the New-York Geological Reports,—that the iron ore is identical with that known there as lenticular clay iron ore, and in Pennsylvania, as fossiliferous iron ore.

Nothing could place in a clearer point of view, the great value of the study of organic remains in indentifying rocks. As this bed of ore, with its associated rocks, is exceedingly persistent, (I have traced it in the State over an extent of one hundred and fifty miles,) it became at once a base line, to which I could refer all the other rocks, that at once marshalled themselves into their proper places, in the order of succession, without further difficulty.

Silurian Rocks of the Cahawba.

The masses of limestone, in the bed of the river at Centreville, which form the lowest barrier in the river, and the head of navigation, are weathered and eroded by the stream in a curious manner. The surface does not weather smooth like the purer limestones, but is covered with points and ridges, and excavated into irregular depressions. Even where the rock is exposed only to the atmosphere, and to rain, the appearance it presents is sufficiently singular to excite the curiosity of ordinary observers. Sometimes the ridges seem to radiate from an elevated point on the rock, as if the fingers had been drawn over it when soft. These elevated parts are more silicious than the rest, and hence resist disintegration, and decomposition, and remain in relief when the other parts are depressed by the constant wasting due to agencies, to which I have already alluded.

Two or three miles above this, on Shultz' creek, a bold stream, upon which are situated the cotton factory at Scottsville, and Camp's bloomery, comes in from the west; after flowing thro' the limestones above the factory, it lays bare the coal measures, which are seen on the left bank of the pond, and again on the dam. At the bloomery, beds of limestone are in contact with the overlying measures, and the neck of land between the creek and the river, is entirely occupied by heavy ledges of limestone. Between the mouth of the creek and Pratt's ferry, they rise up boldly above the bed of the river to the height of

eighty or a hundred feet. The strike of the rocks here being N. E. and S. W. the river, after passing over the coal measures, has cut its channel through them. The road from the ferry to Montevallo passes over the upturned edges of these rocks, and however differently it may appear to the traveller, it is certainly to the geologist, an interesting locality.

A section across the river at this point, commencing on the west, will give the reader a clear idea of the structure and sequence of the rocks at this place.

1. Blue Limestone.
2. Drab colored Magnesian Limestone and Marble.
3. Marble and Blue Limestone.
4. Iron Ore.
5. Variegated Marble.
6. Yellow Sandstone.
7. Black Shale.
8. Cherty Rock with Crinoidal stems.
9. Beds of Gravel, Loam, &c.

1. At the ferry I found, on the weathered surface of this rock, *Maclurea magna*. Although the fossil is imperfect, presenting only the convoluted whirls of the shell in relief, with an occasional section through them, I think I could scarcely be mistaken, and if I am not, this is the equivalent of the chazy limestone, a member of the Black river and Bird's-eye marble group of New-York, and of the blue limestone of the west. It is only exposed at the ferry, being covered towards the north, by the coal measures, and in the west by superficial deposits. There are, however, some beds of black marble with veins of white calx spar running through it, on Six mile creek, on the opposite side of the river, that may belong to this group,—and a rock very similar to this, is exposed on the way to Montevallo.

2. This bed of magnesian limestone, is found along the base of the Red Mountain, almost every where that I have examined the latter. From being lamellar, it passes into the earthy varieties with a dull lustre,—it is sometimes, however, compact, breaking with a smooth conchoidal fracture. The colors vary between a decided yellow, and light drab. It may always be distinguished from the accompanying limestone by its smoothly weathered and white surface.

In the compact limestone associated with this rock, there is often found a layer of concretionary hornstone made up of nodules, generally globular, but frequently assuming other shapes. When seen in place, they are so smooth, and so distinct from the rock, that it requires the hammer to convince one that they are not water-worn pebbles; the concentric layers, however, are quite distinct, and indicate at once their concretionary origin.

3. This stratum is best seen at McMurray's quarry where it appears in a thick ledge on the side of a little stream. Its color is an impure white, with grey stains, that give it, when they abound, a mottled appearance. Veins of green and other colors are often seen.

4. The ore of this bed is composed of grains of various sizes cemented together; the grains are often flattened as if by the superincumbent weight; but in some seams they are quite irregular in this respect, and appear to be made up of water worn particles, and comminuted organic remains. It passes into a conglomerate, and is then mixed with silicious pebbles. Small particles of foreign matter are often present in the ore, and become evident when the specimen is struck with the hammer, by the white points left on the impression made. The presence of carbonate of lime in notable quantity, is an interesting fact connected with this ore, although it is not universal.

There is great variation in the density of specimens even from the same bed, some being compact and heavy, and others light and porous. The casts of fossils which at some localities abound, are lined with yellow ochre. The red color which it so readily imparts to the soil, has also obtained for it a place in the list of domestic dye stuffs, under the name of "dye rock."

5. These are by far the most prominent rocks in this section; they are best seen towards the mouth of Shultz' creek, where they appear on the surface in rugged masses. The ground of of the rock is white and grey, and the colors interspersed through it, are red, yellow, and green. It extends to the river, where it is seen in heavy ledges. There is a bed associated with it,

composed almost exclusively of a yellow calcareous cement and a species of orthis.

6. On the opposite side of the river from the marble, a thin bed of yellowish sandstone is found, and a bed of Brown hematite occupies a ridge parallel with it.

7. A bed of black, shale fifty feet thick, is found on the banks of a little stream along which it extends for more than a mile, and is seen again near Shelby Springs, and in other parts of Bibb County. This shale, which is quite black, and shining in the manner of what miners call "*slickensides*", is sometimes sufficiently carbonaceous to inflame and burn feebly; it is consequently mistaken for an indication of coal, and attempts at exploration are often the result. It is no indication of coal; although, as in this case, it may be in the vicinity of that mineral, it is, nevertheless, geologically, far below the coal formation. It can always be readily distinguished from the shale of the coal measures, by the entire absence of fossil plants. I have yet found no fossils of any description in this rock,* which is doubtless the Marcellus shale of the New York reports.

8. Overlying the shale is a stratum of cherty rock, filled with crinoidal stems, which passes under the beds of loose materials towards the east.

A bed of brown hematite may also be traced with occasional interruptions on the western border of these rocks. At Camp's, on Shultz' Creek, several beds are scattered over the space of a mile or two; but from the manner in which they are worked it is exceedingly difficult to arrive at any correct conclusions in relation to their extent. The surface indication however as well as the occasional pits that I examined, give good promise of an abundance of ore. The hematite of this region seems to occupy a zone of about two and a half or three miles in breadth. It is found again about twenty four miles from Tuscaloosa near the head waters of Hurricane and Rockcastle creeks.

*This is a favorite rock of the practitioners with the "mineral rod" in all parts of the state.

The ore at this place is piled up in the field but I had no opportunity of ascertaining the thickness of the bed from which it is derived.

Green's bed, from which Hill's bloomery has been supplied with ore is about two and a half miles S. E. of this locality; this fine bed comes to the surface near a meeting house a little to the north.

A bed of ore is exposed in a ravine south of the Huntsville road, near the twenty-eight mile post; its extent may be gathered from the quantity piled up in an old field by the road side.

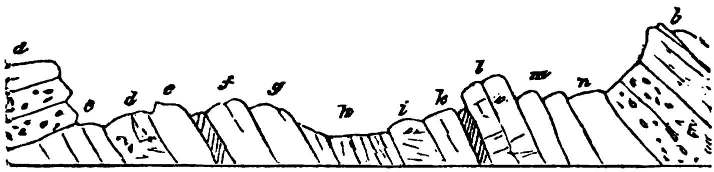
At Murphy's, the ore crosses the road in a bed twenty five or thirty feet in thickness; and that it is not a superficial deposit may be learned by a slight examination of a ravine near the spring.

At McMath's it makes its appearance again, and is continued to Bucksville, where Tannehill's bed occurs, which is at least one hundred feet thick: it is seen there on the top and flanks of a hill enclosed in strata of yellow clay. The distance from Shultz' creek to Tannehill's is about twenty miles, and for eight miles of that distance there is scarcely a half mile where iron ore may not be found.

Roup's valley at Buckville is entirely clear of those superficial beds of gravel that hide every thing lower down, and a section may be obtained across the valley from the coal measures of the Warrior on the west to those of the Cahawba on the east. And although the Red Mountain rocks at this place differ but little from the section at Pratt's ferry, yet they are seen in their relation to the carboniferous rocks far better, for they may be traced up to the very base of the latter; besides, the fortunate occurence of Roup's Creek, that has forced its channel to the Shades Creek almost in the direction of the inclination of the rocks, has laid bare a good section nearly across the valley.

SECTION ACROSS ROUP'S VALLEY AT BUCKSVILLE.

FIG. 4.



a, b—Millstone grit and coal measures of the Warrior on the opposite sides of the valley.
c—Black clay slate.
d—Cherty rocks.
e—Yellowish sandstone and iron ore.
f—Silicious rocks, containing stems of Crinoidea.
g—Sandstone containing iron ore, and passing into cherty limestone.
h—Limestone.
i—Magnesian limestone.
k—Yellow sandstone.
l—Ridge of cherty rocks.
m—Sandstone.
n—Clay slate, underlying millstone grit.

Beginning on the west, with the millstone grit, (*a*, *b*,) which caps a ridge, the slope of which is covered with blocks of this rock, that have fallen down from the escarpment above.

c. At the base of the ridge, a bed of clay slate, nearly vertical, occurs.

d. A bed of coarse and porous cherty rock in thick ledges.

e. A yellow sandstone, passing into grey, and dark reddish brown from the infiltration of the iron ore, with which it is associated.

The ore differs but little from the oxide of iron at Pratt's ferry, excepting that the specific gravity is greater, and that the bed is more fossiliferous. It is probably not more than three or four feet in thickness, but is, nevertheless, very interesting, both on account of its richness, and vicinity to the brown ore.

f. This bed is rendered porous by the number of encrinital stems it contains; they are imbedded in a base of hard chert; the whole resembling, in some degree, buhrstone.

g. Resembles *e*, excepting that the stratification is not so regular. It contains a bed of ore, not so rich as the preceding, but in all other respects similar. This sandstone splits with great regularity, and the partings are often entirely covered with casts of fossils, particularly with those of *Strophomena corrugata*, which have the appearance of having been compressed between the strata.

The yellow sandstone is often covered in a similar manner, with a large Fucoid, constricted transversely, as if it were jointed, the internodes being about half an inch in length.

A bed of impure limestone, with chert, and presenting an unusually rugged surface occurs here.

This is the position of the brown hematite, but the section passes a little north of Tannehill's bed, and as the country is low, it does not actually appear above the surface. The association of this ore, with the cherty rocks, is manifest from the fact that fragments are frequently found in the ore; indeed, it is sometimes rendered worthless by the presence of this rock in too great quantity; it then presents a sort of breccia, the iron forming the cement. It is sometimes mistaken for lime. The chert in this case is pulverulent and chalky, but the harsh touch of the finely divided silica is always observable.

h. This limestone is seen in the village near the spring, and along the road where its broad weathered surface gives it the appearance of horizontal stratification. It makes its appearance along the road at intervals, between Bucksville and a point a few miles north of Elyton; for a great part of the distance the direction of the road coincides with the strike of the rocks, and as the latter are entirely vertical, and as the strata are rather thin and worn by the wheels of vehicles passing over them, they appear like a series of curb stones rising above the surface.

i. Next above these, we have some fine strata of magnesian limestone, that occupy a little knoll on the road side, below Mr.

Tannehill's house. They measure about fifty yards in thickness, and dip S. E. 50°. The rock varies in color between dark grey, and light drab approaching white. But the compact and earthy varieties are found here also.

k. Yellow sandstone resembling *e*, but not so thick. I saw no appearance of red ore at this place, as usual, although it occurs on a neighboring hill, not far distant, in the proper direction.

When this apparent repetition of the same strata, on opposite sides of the valley, was first observed, I was inclined to think that it might be due to those vast folds so common along the Appalachian chain, and which gives the prevailing S. E. dip to the rocks; but on a careful examination, with this view, I am obliged to abandon this opinion. The magnesian limestone, so persistent, and so conspicuous throughout the entire extent of the Red Mountain group, does not occur on the western side of the valley, until we reach the Village Springs, a distance of forty miles above the point where the section under consideration crosses the valley.

The conclusion is obvious, even if the carboniferous rocks were not seen resting unconformably on their edges, that the anticlinal axis of the silurian rocks is hidden beneath the millstone grit, and coal measures.

l. This is a harsh cherty rock, fragments of which are scattered on all sides of the long ridge which terminates at the grist mill. It is much cut up by joints. Though mostly chert, portions of the rock contain lime, and as this is dissolved out, it leaves the rest in a light and porous state. The result of this is often quite remarkable; the silicious particles are left so little coherent, and in such a state of minute division that the rock resembles Tripoli, a substance for which it is said to be a pretty good substitute; sometimes the rock, though quite porous, retains a considerable degree of firmness, and resembles chalk. This process, the solution and washing away of the lime, is best observed in the caves found in the cherty limestones, where the insoluble silicious portions are left standing in relief on the walls and roofs; the lime having been dissolved and carried off.

Among the fossils are casts of a large *Strophomena*, another resembling *S. depressa*, but much larger, and having coarser radiating lines on the depressed margin, and a *Delrthysis* identical with one from the falls of the Ohio.

m. Heavy bedded grey sandstone, seen after crossing the creek, on the road to the bloomery, in large blocks. I have observed no fossils in this rock.

n. In the excavation for the wheel-pit, at the bloomery, a black fissile clay slate was thrown out, which differs from the black shale, in cleaving more readily, and in being less bituminous; it is seen again on the hill side, a few yards distant, where it presents all the characters of ordinary clay slate.

East of this, the ground rises rapidly, and the ruins of the ledges of the millstone grit are strewed over the surface, in the form of large blocks, which have fallen down from the stratum that caps the ridge or Sand mountain. The dip of the grit agrees with that of the rocks just described, and appears to rest conformably upon them. The length of this section is about four miles.

On the right of the road to Jonesborough, the ridge of chert, already mentioned, is seen, whilst the limestones are exposed, in the lowest part of the valley, standing vertically, and in some instances, dipping west, although the prevailing dip is S. E.

The relatively elevated position of this valley is shown by the fact, that not a single stream flows along it, for any considerable distance; for, notwithstanding that it is bounded on the right and left, from Bucksville upwards, by the Sand Mountains, the streams barely cross it to force their way through these barriers, and take their downward course along the coal measures.

The prominent rocks of the Red Mountain group are seen along the eastern side of Jones's valley, to its northern extremity, with almost unbroken continuity, whilst upon the west, they are constantly appearing, or disappearing, as the carboniferous rocks encroach upon, or recede from the valley; a result to be referred to the fact, that on the west the latter rocks

rest unconformably, upon the edges of the Red Mountain group. Directly west of Jonesborough none of the sandstones of the western part of the last section are to be seen.

The number of streams that flow through the millstone grit ridge, or Sand Mountain, on that side, afford ample opportunity of studying the mode of superposition of these rocks.

Five mile creek runs through Jonesborough,* and after crossing the valley obliquely, it passes along the base of the mountain till it finds a gap just above Hamaker's mill through which it escapes to the Warrior.

The silurian rocks of this place are, at their junction with the millstone grit, almost vertical, or stand at an angle of 40°, while the latter dips about 20° N. W.

They consist almost entirely of rough sandstones; and at the ford a little below McAdory's mill, a bed of laminar, black calcareous sandstone, is seen crossing the stream, its vertical edges causing the shoal. Between the creek at this place, and the public road, some very high ridges of chert occur, and are prolonged upwards after crossing the road.

Immediately east of the town, the strata of magnesian limestone, out-crop, near a branch of the creek. This is succeeded by blue limestone, with broad weathered surfaces, covered with soil barely sufficient to afford the cedar its favorite support; and in spots destitute of all vegetation, like bald prairies.

After this, the ground rises, and the mottled limestones, sandstones, and red oxide of iron, the equivalent of the Clinton group, make their appearance on the side and top of the mountain,† and are seen passing east, under the millstone grit on Shade's creek. In the iron ore bed I found the only remains of *Orthoceras* that I have seen in the State.

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* In my explorations about Jonesborough, I was kindly assisted by Dr. Haughey.

† The name of mountain is of such common application, in Alabama, to every elevation, that it is difficult to avoid its use, without danger of being misunderstood.

The Red Mountain approaches the village of Elyton, and although it presents nothing remarkable in the mineral character of its rocks, it is rich in organic remains.

The road from Montevallo crosses a gap in the mountain, and the red soil, and ferruginous fragments scattered about, indicate the vicinity of the red ore, which occupies the summit of the mountain. It is associated as usual with yellow, brown, and white sandstones, and as usual, passes gradually into these.

In the ore I found the caudal shield of a small species of *Assaphus*, having the middle lobe marked by narrow articulations, and a tubercle upon every alternate articulation, proceeding towards the posterior extremity.*

All the varieties figured in the New-York Reports, of *Pentamerus oblongus*, are found here, *Delthyrus brachynota*, and others undetermined. The partings of the sandstone, which is the structure here, are completely covered with hollow casts of fossils, such as corals, crinoidal joints, &c.

The section across the valley at Elyton, presents the common vertical series of limestones, cherty rocks, and sandstones. In a field between the mountain and the village, there is an enormous block of millstone grit, an outlier of the Sandstone mountain. A few miles north of the town a bed of sulphate of barytes occurs, which seems to have been explored for some purpose; it is very white, and free from admixture with other substances.

Towards the west, cherty rocks appear upon the surface near Village creek, but the Sand mountain, which is here scarcely a prominent ridge, is underlaid by vertical beds of limestone.

The town is abundantly supplied with water from a magnificent limestone spring.

* In Dr. Locke's series of plaster casts of trilobites, there is one from Springfield, Ohio, identical with this, called in the accompanying catalogue, "A. tuberculus."

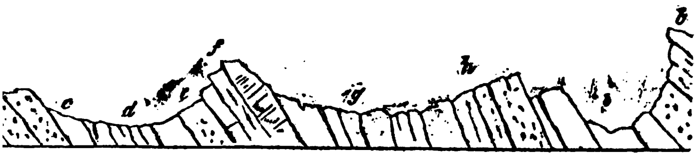
About nine miles north of Elyton, Five mile creek intersects ıe Sand mountain, and here I traced the silurian rocks to the ıillstone grit of the Warrior, which is turned over and dips ıst; but the coal measures above have their usual north wes- ›rn dip.

A little above Elyton the valley is divided longitudinally by high ridge of chert and hornstone, which is crossed by the ›ad from Turkey creek to Springville. At Village springs it ›comes prominent among the hills of millstone grit and red ountain rocks.

Section across the Valley,

Where Five Mile Creek crosses the Sand Mountain.

Fig. 5.



This section represents very fully, the Sand mountain group, it appears between Elyton and Village Springs.

ı—Millstone grit pushed over, and the usual dip reversed.
›—Coal measures of the Cahawba.
ı—Sandstone and red oxide of iron.
l—Vertical limestone.
—Magnesian limestone.
—Hornstone and chert, rising into a bold ridge, and dividing the valley.
—Vertical limestone.
—Red mountain proper.
—Valley of Shady creek.

A few miles higher up, Cunningham's creek finds a passage ·ough a deep and wild gorge in the Sand mountain.

The rocks here also enclose a thin bed of red ore, with as-

sociated sandstones, and in this, as well as other respects, the section presented is similar to that seen lower down.

After passing through the silurian rocks, the stream tumbles down among the ruins of the millstone grit, immense blocks of which are strewed around, in the wildest confusion; of this, picturesque little spot, yet the counterpart is seen at Hanby's mill, where Turkey creek crosses the mountain; the mill stands upon this millstone grit, where it has formed a natural dam across the stream.

At Village springs the strata of the red mountain group trend a little more eastwardly, and are seen for the first time dipping towards the west; and here, too, the carboniferous limestone makes its appearance, resting conformably upon these rocks.

The mottled limestones, and yellowish sandstones are here finely developed.

The ridge is capped by a thick stratum of hard, clinking and dark colored sandstone, that forms an escarpment looking towards the spring. A portion of the limestone is quite red, from the infiltration of oxide of iron, whilst other portions are merely mottled. I found at this locality, well preserved, casts of *Pentamarus oblongus*, and other silurian forms, which are not yet determined. Farther east, the black shale, and cherty encrinital rock, covers the slope of the mountain.

The ridge now continues up Murphree's valley, which terminates near the head waters of the Warrior, and within ten miles of the Tennessee river. This is a remarkable spot; streams that flow into the Tennessee, the Warrior, and the Alabama rivers respectively, commence their descent at this point.

The rocks are continued around the head of the valley, and back, on the opposite side, dipping east; and on all sides overlaid by the millstone grit.

Near St. Clair Springs, a fine ridge of the yellow sandstone occurs, and a thin bed of red ore; the strike of which is N. W. and S. E. These rocks indicate a lateral fold of the strata. The sandstone is quite laminar, and splits very readily, with smooth surfaces; it is often beautifully marked with concentric

and parallel lines, apparently the result of the segregation, and peroxidation of the iron.

The principal spring flows from a bed of lamelar magnesian limestone. About 7 miles from Ashville, the road rounds the spur of a mountain of considerable height, composed of strata very different from any that I had seen among the Red Mountain rocks. At the base is a bed of dark colored fetid limestone, mixed with a chert which runs in curved, and waved bands through the rock.

This is succeeded by thick beds of limestone and cherty rocks, and on the top and back of the mountain, a stratum of silicious conglomerate of extraordinary regularity; it is between eight and twenty inches in thickness, with bedding planes, very even. It is separated from the underlying rock, by a seam of red clay, which facilitates its removal. The slope of the mountain, descending towards the valley of the Coosa, is covered with it, as if with one vast sheet of stone. It is broken up by joints that intersect it in various directions. It differs from the conglomerate of the millstone grit, in being tougher and finer; the embedded pebbles appearing as if blended with the mass. I have found no fossils, and therefore have not been able to refer this remarkable rock to its place in the series. It dips about 40° towards the S. E.

The valley at Asheville is six or seven miles wide. On the east, the Red mountain appears, and the section across the valley presents the usual features—the vertical limestone passing under those of the carboniferous system, and the millstone grit of the Lookout mountain. From this point upwards the valley is bounded on the west by the Lookout; and on the right by the silurian rocks.

At the eastern side of the Red Mountain, one mile from Ashville, a verticle bed of bituminous shale is found, resting upon a stratum of cherty limestone, which succeeds the ore of the mountain.

From this to the Coosa, a succession of strata of limestone and sandstone occurs, giving rise to an undulating and broken surface. A long and high ridge, at the base of which flows

Beaver creek, extends parallel with the road to Green's ferry, where its structure can best be studied.

The lower part of the ridge, for a 100 feet or more, is made up of heavy ledges of limestone, and the upper silicious strata are finely displayed at the head of Ten Islands, where the river has cut through the mountain; indeed, both the shoal and islands are due to the indestructible nature of these rocks.

On the left bank, after crossing the ferry, the road-way has been excavated in a thick bed of sandstone, which extends across the river at the head of the shoal. This rock, which is very hard and compact, has, below the surface a greyish blue color, in this respect resembling the blue limestone, for which it is sometimes mistaken, but on the surface it is yellow, and sometimes even white and somewhat porous, in which case it forms a pretty good firestone, and is scarcely distinguishable from the sandstone of the millstone grit. The mass contains imbedded fragments of clay slate, both red and yellow.

It is succeeded by a bed of ferruginous sandstone, such as I have described, as giving evidence of the neighborhood of the red ore, but the latter I did not find present in any useful quantity; still, further search will doubtless bring it to light, along the ridge.

This passes into a dark colored conglomerate, which is succeeded by an olive colored sandstone, very close grained and hard. This group gives rise to what are called the Coosa mountains, which are seen towards the east in long ridges, with the usual sharp and severe outlines of sandstone mountains.

So far as I have seen this region, it consists of a series of ridges, with limestone valleys between.

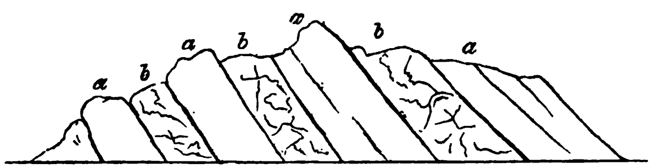
The same features characterize that part of Shelby east of Montevallo, excepting that the ridges are less bold. Yet the alternations of silicious rocks and limestones are quite conspicuous, and the corresponding changes in the growth of the country is matter of common observation. The pines find their favorite soil along the sandstone and cherty ridges, whilst the oak and other trees flourish in the valleys.

I was not a little surprised to find in Benton, in extent, the counterpart of the beds of brown hematite of Bibb and Tuskaloosa counties.

The Benton iron works are situated on Cane creek, about four miles south of the battle ground; the bed of ore commences at the furnace, and for about two miles upwards it is found at intervals in two parallel beds, with cherty rocks intervening. Fragments of this rock are occasionally found imbedded in the ore as in Bibb.

The following section represents the manner in which these fine beds are disposed.

Fig. 6.



a, a, a. Cherty rocks. *b, b, b.* Beds of ore.

As far as I examined this locality, the beds became thicker towards the N. E., and at the last excavation made, the ore appeared in a bed 50 yards thick; and what is quite important, it is confined to a high ridge. This ridge, I was informed, extends far beyond the point where my examination closed.

In St. Clair county, I examined a ridge of silurian rocks that separate the little coal field of that county from the Coosa; it is composed of alternating strata of cherty rocks and limestone; and here, too, I found a good bed of brown hematite, on the top and along the slope of the ridge towards the river. This ridge extends parallel with the river, between Broken Arrow creek and Collins's.

The principal hematite beds of Shelby extend from the mouth of Little Cahawba to Montevallo, almost on the verge of the coal measures, and, at farthest, removed from it but a few miles. I have, as yet, examined this belt very slightly, but the ore has been used for years in the bloomeries of the Cahawba, and its quantity and quality are well understood in that region. There remains one other locality of silurian rocks to be described.

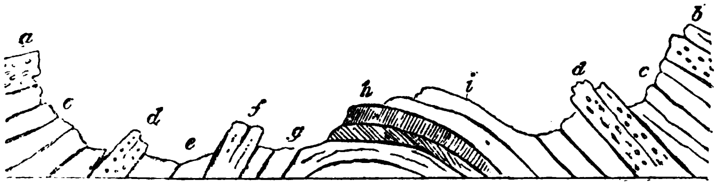
From the N. E. corner of the State, the valley of the Tennessee river runs in a S. W. course to Gunter's Landing, and although the river changes its direction at this point, the valley continues through Marshall and Blount counties. Warrenton, Blountsville, and Blount Springs, are situated in this valley, which terminates a few miles below the Springs.

Throughout the whole distance, the carboniferous rocks are pushed up by the silurian strata, although the latter only occasionally make their appearance at the surface. And at the lower end of the valley, the carboniferous limestone is not broken through, yet the influence of this anticlinal axis is felt among the coal measures as low down as Old Warrior town, and the millstone grit sometimes raised to the surface.

In this valley, perhaps the most interesting locality is that at Blount Springs, where the relations of the silurian, and the overlying newer rocks may be studied. The Springs are situated in a narrow cross valley or gorge running at right angles with the principal one; a small stream fed by springs situated higher up, exposes in its bed, as it crosses the valley, rocks that cannot be seen elsewhere. The section represented here passes along this stream.

Section at Blount Springs.

Fig. 7.



a, b—Millstone grit capping the mountains east and west of the deep valley of the Springs, and quite conspicuous on the west.

c, c—Carboniferous limestone, forming the mountains on each side of the valley. On the west the old academy stands upon this rock.

d, d—Strata of millstone grit occurring in the carboniferous limestone; the one on the west forms a ridge parallel with the road in front of the Springs.

e—Silurian limestones.
f—Ridge of chert upon which the hotel stands.
g—Dark colored limestone occupying the area of the Springs.
h—Black shale.
i—Thick beds of coarse silicious limestones.

The strata millstone grit overlying the carboniferous limestone, form the edges of the troughs of the Locust and Mulberry Forks of the Warrior, and are crossed in approaching the Springs from the east or west.

The beds of millstone grit seen in the section at *d*, *d*, run parallel with the principal valley, forming distinct ridges, the western one of which is seen in front of the gate leading to the Springs. These rest conformably upon the silurian rocks. At *f*, a thick stratum of cherty limestone occurs, with imbedded angular fragments of hornstone; this is the rock upon which the hotel stands, and may be studied on the west side of that building; it rises up in front of the dormitories, and forms a prominent knoll; it is also conspicuous above the limestones upon the opposite side of the stream, and back of the hotel. This rock is underlaid by a stratum of soft, and dark colored limestone, disposed in thin beds, and made up, for the most part, of innumerable fragments of crinoidea and corals, and is the rock from which the mineral waters flow. It is best seen on the floor of the area occupied by the springs. It occupies the summit of the anticlinal axis of the valley; in the centre of the area the strata are nearly horizontal, and at the upper end, they appear slightly arched over, a disposition that may also be observed in the superincumbent rock.

Continuing up the ravine, above the springs, the next rock in the section becomes visible; this is the bituminous shale, which I have had occasion to mention so frequently. It is best examined at a vertical section which occurs above the row of cottages situated immediately under the hill. A quarry had been opened in it here, for the purpose of procuring building stone; the joints by which it is intersected, have produced smooth faces, which appear to have tempted the architect of the row of cottages just mentioned, to its use as a building material. A slight knowledge of the character of rocks would have taught him, at least, a little caution. The sulphuret of iron, so abund-

ant in it, is slowly, but constantly undergoing decomposition, and the result is, the total destruction of the rock. The walls of these cottages are covered, where the rock is exposed, with sulphate of iron and sulphate of alumina. Above this stratum, which is about 80 feet in thickness, are beds of coarse horizontal limestones, the partings of which are covered with bodies in relief, resembling fucoids. Specimens of this rock are seen in the steps of the hotel, which were taken from a quarry higher up the valley. This rock, with alternating limestone, occupies the mountain, which separates the valley from the carboniferous limestone on the east.

I have endeavored to present the structure, and other relations, of the rocks of these interesting valleys, in as clear a point of view as possible, because of their importance in connection with the carboniferous rocks, and because they present, in a comparatively limited space, the means of studying the southern termination of the silurian rocks of the United States. Besides, of these rocks, in other portions of the State, I have as yet seen but little, and I feel, that even here, I have gone over too much ground to entitle what I have done to more than a reconnoissance, to be extended by future explorations.

CHAPTER III.

Economical Relations of the Red Mountain group.

Iron Ores—Hydrous Peroxide of Iron—Specular Oxide—Analysis of Ores—Mining and reduction of Ores—Furnaces of the State—Red Ochre—Lead Ore—Peroxide of Manganese—Limestones and Marbles—Lime Burning—Hydraulic Limestone—Flagging Stones—Grindstones—Millstones—Alum—Tripoli—Mineral Waters.

1. *Iron ores.*—The value of ores of iron, depends upon a few obvious conditions, such as the quantity of the ore; its

quality; vicinity to fuel and materials for flux; together with the certainty of a fair market for the iron produced from the ore.

The first of these conditions has, I think, been placed beyond doubt; so that we may pass on to the consideration of the quality of the principal ores of the State.

Hydrous Peroxide of Iron.—This species of ore is known under the following names: brown oxide of iron, brown iron ore, and brown hematite; it also includes the brown and yellow ochres. It has, hitherto, furnished all the iron works of the State, and these, being for the most part bloomeries, this fact alone furnishes no bad test of its quality and value; for it is only the purest ores that can be worked profitably, in this way. There are several varieties recognised at the works, some of which are preferred by the manufacturers, to the rest. This preference is not confined to the richest ores, nor, I believe, in every case, to the most valuable.

Among these varieties are fibrous brown hematite, a rich ore, having a fibrous structure and silky lustre; but not in great repute at the furnaces, although said to work well at the bloomeries, and the ochery and cellular ores, which are supposed to work well in both. This last variety, is a porous mixture of yellow ochre and compact ore, and is highly prized. There is another variety, having a dull lustre, and compact structure, of which a large amount of every bed is composed.

That the estimation of the value of ores will be greatly modified, if not reversed, with the spread of more correct knowledge, there can be no doubt.

Specular Oxide of Iron.—Under this specific name, are included all the ores known as, red iron ore, red hematite, red ochre, fossiliferous iron ore, and lenticular iron ore. The variety of this ore that occurs in Alabama, and which has been shown to be so widely diffused, is known in Pennsylvania under the name of fossiliferous ore, and in New York under that of lenticular clay iron ore. In both of these States it is extensively used and highly valued. Notwithstanding the great abundance of this ore, and its favorable position, it is scarcely recognised, by our iron manufacturers, as an ore of iron;* so that

* I heard of one or two unsuccessful attempts being made to reduce it in the bloomeries.

the only useful purpose to which it has been applied, is that of a domestic dye stuff, and is hence every where known as "dye rock." It varies a great deal in quality, being sometimes porous, and at others rendered impure by silicious particles; the latter may be detected by the hammer: if impurities be present, in the form of grains, they will appear white where the specimen is crushed by the blow. A remarkable circumstance connected with the composition of this ore is, that it contains carbonate of lime; a fact that, if it were constant, would render the addition of lime as a flux unnecessary; I find, however, that it is only the ore from certain beds that contains this mineral.

It may be interesting to our iron manufacturers to know the estimation in which this ore is held in New York and Pennsylvania. I therefore present some extracts from the geological reports of these States:*

"This mineral, which is now known by the name of argillaceous iron ore, is now generally considered to be a variety of the specular oxide of iron. It is very interesting to us, in consequence of its great abundance in the western part of the State. There seems to be two distinct beds or strata of ore in the protean group of Mr Vanuxem, arranged, in lines parallel to each other, extending from the county of Herkimer to the Genessee river. These beds, liable, however, to some interruptions, are usually about twenty feet from each other, and vary from one foot to two and a half feet in thickness.

"This ore consists of lenticular or flattened grains of various sizes, which apparently have been made to cohere by the pressure applied to the mass. It frequently contains joints or disks of the encrinite, and fragments of other organic remains. Its usual color is brownish red, its powder being more red. It is very friable, soils the fingers, has but little lustre, and is often studded with minute grains of iron pyrites. The specific gravity of a fair specimen from Wolcott, in Wayne county, is 3.740. All the samples that I have examined effervesce freely in acids, which is probably due to the admixture of carbonate of lime.

* Dr. Beck's Report on the Mineralogy of New York, 1842.

"In Oneida county, numerous pits have been opened in the towns of New Hartford, Kirkland, Vernon, Westmoreland and Verona. There are three beds of ore in this county, varying from twelve to twenty inches in thickness. They have been long and extensively worked, and, although containing a less proportion of metallic iron than many other ores, are nevertheless highly valued by iron smelters. Previous roasting improves its quality, and is indeed often quite essential to its successful reduction, in consequence of the presence of iron pyrites.

"In Wayne county, a stratum of the lenticular ore has been found extending through it, and at about two miles distance from Lake Ontario. In the immediate vicinity of Wolcott, there is a bed of about a foot in thickness. About a mile north of the village is a furnace, which is now supplied with ore from the eastern part of the town, where the stratum of ore is about three feet in thickness."

"The following are the results of an analysis of a specimen of the lenticular clay iron ore from Wolcott:

Peroxide of iron,	51.50	Silica,	6.00
Carbonate of lime,	24.50	Alumina,	7.50
Carbonate of magnesia,	7.75	Moisture and loss,	2.75

"In point of abundance, it cannot be compared with the magnetic oxide, nor is it equal to that ore in purity. It, however, yields an iron which is highly valued for various purposes, especially for castings; and when mixed with other iron ores, it greatly improves their quality."

Prof. Hall says of the same ore:* "The argillaceous ore makes a hard, brittle iron. When melted without any flux, it is too sharp, i. e., the cinder is equally as fluid as the iron, from which it does not separate, but will sometimes run to the end of the mould. The melted mass is too thin, and therefore it is necessary to mix loam with the ore. At the Wolcott furnace, Mr. Hendrick uses one part of sandy loam to two parts

* Report, Geol. of N. York, 1843.

of ore, upon which the cinder separates, and perfect castings are produced. Mixed with the rock ore, or magnetic oxide from Canada, in equal parts, and also in the proportion of two parts of argillaceous to one of magnetic ore, a softer and better iron is produced.

"The argillaceous oxide requires a high heat for melting, and consumes one-third more charcoal than the harder ones. There is always produced considerable carburet of iron in thin bright scales or leaves, exactly resembling plumbago; we have also seen this substance formed from the magnetic ores of iron at a high heat.

"When casting plough irons, they run them upon a *hardener* (which is a piece of cold iron) so that for two inches on the edge, which is liable to wear, the castings are hardened like steel. The effect is, to change the usual granular texture of the casting into one that is lamellar, like bismuth. This difference is perceptible, and the line of demarcation is also very evident when the casting is broken.

"Ontario furnace is situated upon Bear creek, about two miles north of the ridge. The argillaceous iron ore is extracted in two places in the immediate vicinity of the furnace; it is a continuation of the same stratum that is explored in the towns of Sodus and Wolcott. The layer of iron ore is situated about fifty feet above the surface of Lake Ontario. Solid ore occurs about three feet thick, and to a greater extent mixed with rock; it is clean, of a bright red color, exhibits its fossils very distinctly, and its characters are generally similar to those of the Wolcott ore. It is said to yield from 33 to 35 per cent. of metallic iron. The iron which it forms is brittle, and is employed for large castings, as potash kettles, ploughshares, &c. Bog ore improves it. The ore is quarried and delivered at the furnace for $1.50 per ton. There were formerly manufactured at this furnace 300 tons of iron per annum. This ore was first dug during the last war, carried to Auburn, and ground for paint, of which it is said to form a good article, with the addition of a little red lead."

And Prof. Rogers,* speaking of this ore, says "that the de-

* Geological Report Pa., 1839.

tailed and systematic examination undertaken for this highly valued species of ore, consumed a considerable portion of the season" devoted by his corps to the exploration of the State. He was induced to do this "from the great importance to the iron manufacture in these counties, of the fossiliferous iron which occurs only in this formation." And in Virginia, he informs us, "the same valuable fossiliferous iron, which imparts such interest to this formation in Pennsylvania, still accompanies the stratum, being met with in beds from six to eighteen inches in thickness."

Composition of some of the principal Iron Ores of the State.

Red Oxide of Iron, from the bed near Pratt's Ferry.

Peroxide of iron	61.50
Insoluble matter and loss	36.20
Carbonate of lime	2.30
	100.00

This specimen, which represented pretty fairly the best portion of the bed at this locality, contains 42 per cent. of metallic iron.

Red Iron Ore from the bed near Bucksville.

Peroxide of iron	65.00
Carbonate of lime	trace.
Insoluble matter and loss	35.00
	100.00

The amount of metallic iron is equal to 45.

Brown Hematite, from Tannehill's.

Peroxide of iron	78.00
Insoluble matter and water	21.00
Oxide of manganese	1.00
	100.00

This ore contains about 53 per cent. of metallic iron.

Fibrous Brown Hematite, Ware and McClanahan's.

Peroxide of iron	82.00
Water and insoluble matter	18.00
Oxide of manganese	trace.
	100.00

Contains 57 per cent. of metallic iron.

Ore from the Benton works, variety from the northern extremity of the bed.

Peroxide of iron	80.00
Insoluble matter and water	19.50
Oxide of manganese	0.50
	100.00

This was an average specimen of this fine bed. It contains about 55 per cent. of pure iron.

MINING AND REDUCTION OF THE ORES OF IRON.

Mining operations are, throughout the State, conducted with one special object—present *cheapness*; it cannot be called economy, without any reference whatever to the future. To effect this, the surface of the bed is skimmed, and the covering, when taken off, is often thrown where it must be again removed, and in numerous cases, things are so conducted, as to make future operations difficult, if not impossible. And, after all, I am persuaded that the end contemplated is not accomplished, and that the proprietors would find systematic modes, far more profitable, even in relation to the present, than these unworkmanlike practices. Fortunately, expensive mining operations are not necessary with us; the beds of ore are thick, and in every instance, situated on high ground, so that but little skill is required in the extraction of the ore; and if the labor employed were but rightly directed, it would leave little to be desired.

Nothing can show, more clearly, the moderate state of information on the subject of the reduction of iron from the ores,

than the assertion constantly heard, even at the works, that certain ores yield 70, 80, and even 90 per cent. of iron.

With the view of directing attention to this interesting subject, I trust I may need no apology for introducing here, a few elementary principles, which lie at the foundation of metallurgic operations in relation to the ores of iron.

It is now almost matter of common information, that, when substances unite chemically, they do so in exact proportions: for example, water is composed of two simple substances, oxygen and hydrogen united in this proportion:

Oxygen......8
Hydrogen...1

And the sum of these, 9, is the combining number of water, or the proportion in which it combines with other substances.

Limestone is made up of carbonic acid and lime, and each of these is composed of two simple substances, thus:

Carbonic Acid.		*Lime.*	
Carbon	6	Calcium	20
2 Oxygen	16	Oxygen	8
	22		28

And these added, give the number that represents the equivalent or combining number of limestone, which, in chemical language, is called carbonate of lime.

Lime	28
Carbonic acid	22
	50

When a piece of polished iron is exposed to a damp atmosphere, it combines with oxygen, and forms rust, or oxide of iron, which is the simplest form of iron ore, being composed of iron and oxygen in this proportion:

Iron	27.14
Oxygen	8.00
	35.14

This being the lowest proportion in which oxygen unites with iron, the compound is called the *protoxide;* and the highest is called the *peroxide* of iron: it is in this last state that the ordinary ores exist, thus:

2 iron	54.28
3 oxygen	24
Peroxide of iron	78.28

Hence, then, in 78.28 parts of the ore, there are 54.28 parts of iron; and to find the amount of iron in 100 parts of ore, we have the simple proportion: 78.28 : 54.28 :: 100 : 69.34. Consequently, 69.34 per cent. is the highest proportion of metallic iron that such ores can yield. But the brown hematite has also in combination 14.7 per cent. of water; and in order to find the amount per cent. of iron, we must subtract this from 100 parts of the ore; we will then have the proportion: 78.28 : 54.28 :: 100–14.7 : 59.13; so that 59.13 per cent. represents the iron in 100 parts of brown hematite, supposing it to be entirely pure, which is very rarely the case, for the ore is generally mixed with silicious and argillaceous matter, and manganese.

The following table exhibits the proportion of iron in the workable ores, when perfectly pure:

Carbonate of the protoxide	47.74
Brown hematite	59.13
Specular oxide or red hematite	69.34
Magnetic iron ore, grey ore	72.40

The first operation in the reduction of the ore, consists in the roasting, which is commonly effected in the open air, in clamps formed of alternate layers of ore and fuel, piled one above the other. A more economical mode is adopted where fuel is scarce, and the ore is roasted in kilns; this method, besides saving fuel, prevents the fusion of the ore, which sometimes happens in clamps, and which should always be avoided.

This is by far a more important operation than it is generally accounted, and should be performed carefully, as will appear after a moment's consideration of the effects produced.

1. The water, carbonic acid, sulphur, and other volatile matters, are driven off, that would otherwise abstract a large amount of heat from the furnace.

2. The ore is by this means rendered porous, so that the heat and flame of the furnace can penetrate it more readily, and reduction takes place before the silica, present in the ore, has

time to form a chemical combination with it, which would otherwise form a very refractory compound.

In the roasting that I have observed at the furnaces, the largest masses are put in the clamps, just as they come from the mine. Now, it is obvious that under such circumstances, not one half the ore can be properly roasted, and that, consequently, the important effects just stated, cannot be accomplished. This, I apprehend, is one of the principal reasons why the rich but compact ores, which, in a special manner, require this process, are not in good repute with our smelters, who prefer the more porous but poorer ores. After the roasting, the ore is ready for the furnace; and were it composed of iron and oxygen alone, all that would be necessary for its reduction, would be to heat it, in contact with carbonaceous matter, such as charcoal, the oxygen would combine with the carbon of the charcoal, and some carbonic acid, which would pass off, leaving the iron free.

This is the process of the bloomery, or Catalan forge, which is the simplest form of surface; and where fuel and ore are abundant and cheap, and capital scarce, it answers very well. It is further recommended by the circumstance, that operations may be suspended, or resumed, without much cost; it consequently enables the farmer to devote his season of leisure to the production of this indispensable article; nevertheless it must be conceded, that besides being limited to the production of malleable iron, it is wasteful in the last degree, of both ore and fuel. In relation to the latter, the fact that bloomery cinder has been worked profitably in high furnaces, is conclusive. It is evident, that, in this process, where the ore has other impurities, such as clay, silica, &c., they must combine with a portion of the iron, which is lost to the product. Recently, attempts have been made to improve this furnace, and the processes in common use: the nature of these improvements will appear from the following extract, taken from the Patent Office Report of 1847:

"The process and apparatus heretofore resorted to in bloomeries, for preparing the loup or bloom for the trip-hammer, are attended with many disadvantages. The forge fire is such that the ore and other materials for the loup cannot be placed upon

it at once—but as large a mass as can be accommodated is placed upon the fire, and as the impurities are driven off, and the mass diminishes, another portion of the ore, and other materials are added, and this repeated till the loup is formed and prepared for the hammer. In this process, as the forge is open on all sides, it will be perceived that the outside of the mass is constantly exposed to the atmosphere, which cools the mass, and otherwise much retards the process, rendering much time and fuel necessary—and as the mass is partially reduced, the addition of cold materials produces a similar effect. These new materials require additional time for reduction, and the same is true of the succeeding additions, and it is therefore evident that those portions of the ore, which were earliest placed upon the fire, are kept there much longer than is necessary, and are in danger of receiving injury therefrom, and the incongruous mass is with great difficulty brought into the same condition, and prepared for the hammer.

"To obviate these inconveniences, the patentee in question prepares a close chamber for the reception of the charge, and of sufficient size to receive the whole charge at once; the upper part of the charge is supported, in some degree, by moveable bars extending across the chamber, and there are suitable doors which may be opened when necessary, for the reception of the charge, for the working of the loup, and for removing it when ready for the hammer. When the loup is nearly reduced, a new charge is introduced, and made to rest upon the bars above mentioned, so as to receive all the benefit derivable from the heat which would otherwise be lost. The advantages of these improvements appear obvious, and they are said to be in successful operation, effecting a great saving of time and fuel, and increasing the quantity and improving the quality of the iron."

There has also been patented a substitute for the common trip hammer, which is called "Burden's Shingling Machine," that is considered a capital improvement.

I have not yet learned whether these improvements have been sufficiently obvious to induce manufacturers to return to

this primitive process, excepting in the cases to which I have alluded.

In the high furnace, substances called fluxes are added, which combine with the earthly impurities, rendering them fusible, so that they let go as it were, the reduced iron, which sinks down to the hearth, and the compound formed by the flux and impurities, called the cinder or scoria, floats a liquid mass upon the surface of the molten iron, and is drawn off.

Much of the skill of the smelter consists in the adaptation of the flux, both in kind and quantity, to the ore. He must, therefore, be thoroughly acquainted with the nature of the ore, fuel, and flux, as well as with the operations going on in the furnace. The form of the furnace, the angle of the boshes, and the volume and pressure of the blast are all subjects that must occupy his attention, who would be a successful iron-master, and keep up with the progress of this interesting branch of metallurgic science. These have all been studied with great care in Europe. and in parts of our own country.

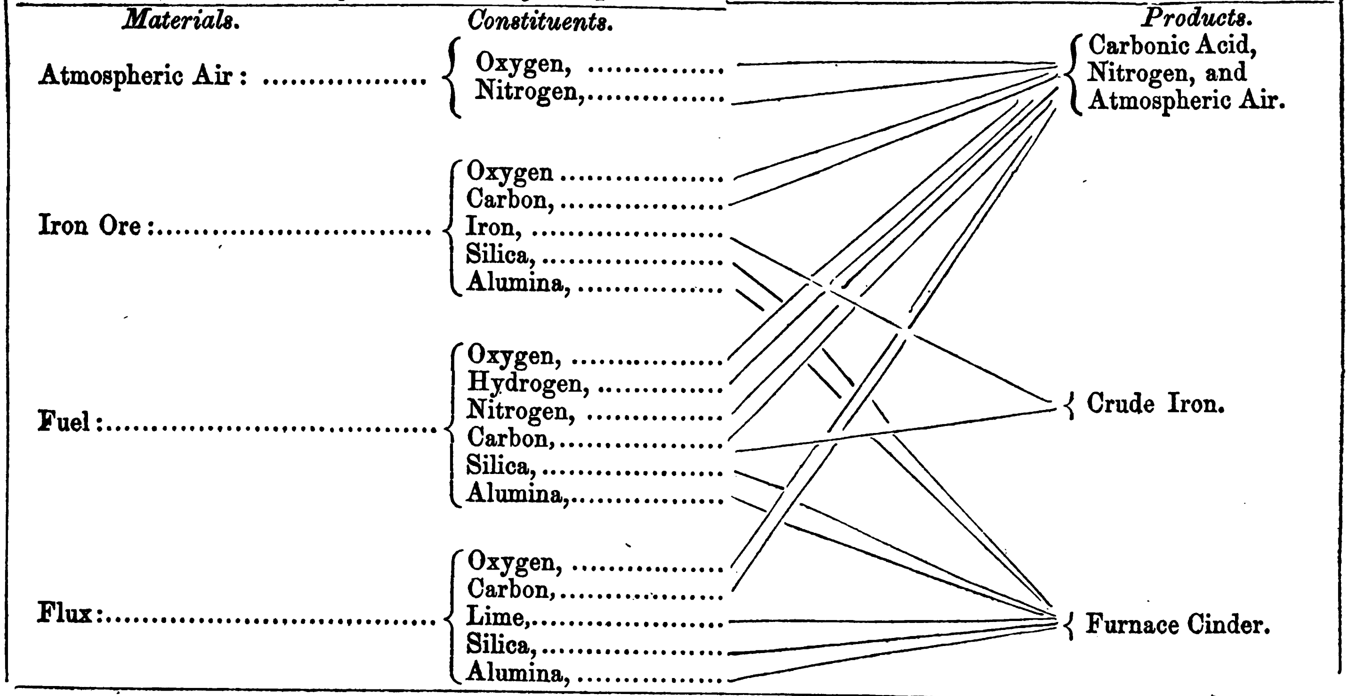
The application of heated air to the blast, has produced a great improvement in the economy of the high furnace, and it has very materially affected even the product of the bloomery. When it is stated that more than one-half of the heat of the furnace escapes at the trundle-head it will be seen that there is yet a wide field for improvement.

The following diagram is intended to explain the course taken by the materials placed in the furnace, and the products produced.

These materials are either solid or gaseous, as are also the products. The solid materials are the ore, flux, and fuel, and the gaseous portion is the atmospheric air sent into the furnace in the blast.

The solid products are the furnace cinder, or scoria; and the gaseous products are carbonic acid, nitrogen, and steam, which escape at the trundle-head.

Diagram illustrating the operations going on in a Blast Furnace.



At this moment the manufacture of iron is attracting the attention of our citizens, and, as much depends upon a good beginning, these hints are offered with the view of directing enquiry in the proper channel. It is not wise to spend both time and money in working out problems that have been, long ago, solved; if we begin at all, let us do so with the present state of the art.

There are eight bloomeries in the State, two of which are on Talladega creek, and the others on the waters of the Cahawba.

Of the two high furnaces, one is in Bibb county; it has but recently been erected, so that its operations are, as yet, confined to the manufacture of pig iron and hollow-ware; the blast is urged by steam power, and the boiler is heated directly from the trundle-head. These works are situated within eight or ten miles of the Coosa, and from the convenience and good quality of the ore, and the abundance of fuel, they can scarcely fail of success, under ordinary good management.

The Benton works are situated on Cane creek, a short distance from the river; they have been for years in successful operation. An extension of the works, the introduction of the hot blast, and various other improvements are contemplated, which, when accomplished, will place this among the most complete establishments at the South. The following brief statement was politely furnished by one of the proprietors:

"POLKVILLE, *Benton Co., Ala., Sept.* 26, 1849.

"We have a blast furnace, a puddling furnace, and forge, in operation. We turn out daily about 6000 pounds of iron: 2000 lbs. of which are put into hollow-ware and machinery-castings, 2000 lbs. into bar iron, and 2000 lbs. into pigs. We use 600 bushels of charcoal every 24 hours. Our iron ore beds (some of them) are within 600 yards of the furnace. Our limestone is at the furnace, and in abundance. The nearest stone coal beds that have been worked, are thirteen miles off. We are now preparing to put up a rolling mill, and think that in a short time, we will be able to roll iron successfully. Our establishment is five miles east of the Coosa river, opposite the Ten Islands, and eleven miles from Greensport. We ship our iron down the Coosa in flatboats to Wetumpka, Montgomery,

and Mobile. We have found the articles we produce here of ready sale in either of those markets. We are prepared to make, turn off and fit up all kinds of machinery, except fine castings for cotton mills, and will be very soon ready to furnish these."

Red Ochre.

There is a bed of red ochre near Bucksville, which I have had no opportunity of examining in place, but the specimens that I have seen, show that it would require but little preparation to fit it for paint. It is sufficiently rich to be used as an ore of iron.

Lead Ore.

Fragments of sulphuret of lead, or galena, are scattered throughout the State in a manner that would indicate some common origin. Had they been confined to the region of the silurian or carboniferous limestone, one might refer them to the ruins of veins of this ore that are often found in these rocks; but they are equally abundant where this is impossible. I have specimens picked up on the surface of the coal measures, and others from Clarke county, where no such veins can occur. Pieces of considerable size are found in the vicinity of Indian mounds; and the belief is induced that the position of these scattered fragments may be traced to Indian origin.*

*All the States, from which the Indians have recently departed, have legends of lead and silver mines, that were known to, but afterwards hidden by, them; and the tenacity with which these are believed and retained, is truly surprising. Journeys have been undertaken to the west to ascertain the position of these mines, but hitherto without success. The Indians, being no geologists, located the mines, in the cases that have come to my notice, in the most unpromising positions. The men with mineral rods have been industriously on the trail, and I must do them the justice to say, that where they indicated the presence of "mineral," the excavation was neither expensive nor difficult. The one I last saw was in an Indian mound, on Village creek, where the miners had reached within one foot of the vein!

However this may be, it is quite certain, that much time is unprofitably spent in searching for these mines.

Lead is found in limestone near the iron works in Benton, which is the only place that I have seen it in the State. The ore is granular, and does not occur in a true vein with smooth walls, but is closely attached to the rock, and passes into it in irregular bunches. It may be traced over a distance of ten yards, and although it is not more than an inch or two in the thickest part, it may turn out to be worth the trouble of an examination below the surface. It is a pure sulphuret of lead; the cavities in it are often lined with crystals of the carbonate of that metal. The ease with which lead is reduced allows of considerable expense in mining, and I would recommend the enterprising proprietors of the iron works, to examine this locality with some care. The existence of veins of calx spar, and sulphate of barytes, are favorable indications.

Peroxide of Manganese.

At the works just mentioned, a fragment of ore, which was brought there for an ore of iron, attracted my attention, and proved, on examination, to be peroxide of manganese. I have since learned that the bed from which it was taken is probably three or four yards in thickness. This ore is used in the arts for the production of chlorine gas, which is used in bleaching establishments. The gas is combined with caustic lime, by a simple process, and in this form is barreled up and preserved for use.. The gas is extricated from the lime, by meaus of water, which absorbs the chlorine, and is then ready for use. As there is lime in abundance where this occurs, chloride of lime may be manufactured. The price of the mineral itself, is about $20 a ton. The specimen I examined was quite porous, and mixed to some extent with earthy impurities, but nevertheless it contained 35 per cent. of peroxide of manganese. I trust that when this bed is fairly opened, that it will turn out to be an important acquisition to the resources of Alabama.

Limestones and Marble.

The term marble is applied to any variety of limestone that is susceptible of a polish.

I have mentioned already, the occurrence of beds of marble of great thickness on the Cahawba. Many of the beds there, afford specimens of great beauty; some are grey with red veins, others are red and yellow, and specimens with greenish veins are not uncommon. There is also a buff colored marble there, filled with organic remains, that is quite handsome when polished. Beds of white crystalline marble, clouded with red, occur. On the opposite side of the river, there is a black compact marble, and another on Six mile creek, variously intersected by veins of white. A marble of similar quality occurs on the road from Pratt's ferry to Montevallo.

As no quarry of any extent has been opened, at any of these places, it is impossible to give a correct view of their value. Marble to be valuable, must be found in thick beds, that are free from cracks or joints. Of the thickness of the beds there can be no doubt, nor does there appear to be any reason to suppose that the other conditions are less favorable. I look upon this locality as one of great interest, in connection with the industrial resources of the State.

The principal exposures occur near the head of navigation, and on the immediate banks of the rivers.

On the Huntsville road, about 19 miles from Tuscaloosa, ledges are found that would afford pretty good marble.

At Jonesborough, beds of variegated marble, of the red and white variety, occur. The rock is compact, and lies in thick masses, at the base of the Red mountain. The same stratum occurs at Village Springs. The magnesian limestone, when compact, is susceptible of a polish, and its peculiar soft grey color, I think beautiful; in addition to this, it is extremely durable. The crystalline varieties are also used as marbles.

These rocks, as I have shewn, extend from Shultz' creek to the upper end of the valley.

When an outlet to this region is provided, the value of these beds will be appreciated.

At the locality mentioned, on Big Sandy creek, very good marbles occur, which are, in many respects, similar to those of the Cahawba. As there is abundant water power at this locality, which has already been turned to account by the enterprising proprietor, who has erected a cotton factory here, may

we not hope, before a long time, to find also a saw-mill, for marble, in operation.

LIME BURNING.

Limestone being a compound of carbonic acid and lime, in order to obtain the latter, it becomes necessary to drive off the carbonic acid, and this is best effected by heat. Of course the quality of the lime will depend upon the purity of the limestone; but, for architectural purposes, the presence of magnesia, silica, and alumina, in certain proportions, is not detrimental, but on the contrary, adds to the strength of the mortar made from the lime.

The following analyses will shew that the limestones of the State are well fitted for the manufacture of lime.

Limestone from Pratt's Ferry.

Carbonate of lime, - - -	93.00
" magnesia, - - -	2.10
Silica and loss, - - - -	5.00
	100.00*

Limestone from the Quarry of H. Clements, Esq., Big Sandy.

Carbonate of lime, - - -	90.00
" magnesia, - - -	3.00
Silica, alumina and water, - -	7.00
	100.00

Limestone from McMurray's Quarry.

Carbonate of lime, - - -	88.00
" magnesia, - - -	4.00
Silica, &c. - - - -	8.00
	100.00

* Mr. Olmsted.

These limestones are from the lower extremity of the formation, and the points nearest the head of navigation.

The modes of burning lime, will depend upon the kind of fuel, and the extent of the operations contemplated.

In some countries, lime is burned in clamps, where the broken stone is piled in alternate layers with wood, and when ignited, the whole is covered over in the manner of a charcoal clamp. This is an obvious improvement on the common mode in use with us, of burning lime in a "log heap;" besides, the lime thus produced, is much prized for its good quality. Two forms of kiln are in common use; the one is called a perpetual kiln, because the fire is kept up without intermission. Anthracite and bituminous coal are frequently used in this form of kiln. When the kiln is fired, a layer of broken stones, one foot deep, is formed, which is covered by one of coal, three or four inches deep, and this is continued until the kiln is filled. When the lower layers are burned, they are drawn off, and after each drawing, other charges are added at the top, so that, it is plain, this process may be continued without intermission.

In the other form of kiln, the fuel is applied below, under an arch formed of the stone to be burned. In this kiln, when the calcination is completed, the whole charge must be drawn off before the operation can be renewed; therefore, a great waste of fuel is inseparable from the use of this form of kiln. But when wood is abundant, and the demand for lime not great, it answers very well.

With the view of directing the attention of our citizens to this important industrial resource, I have thought it proper to present them with one or two of the most approved and simple forms of kilns.

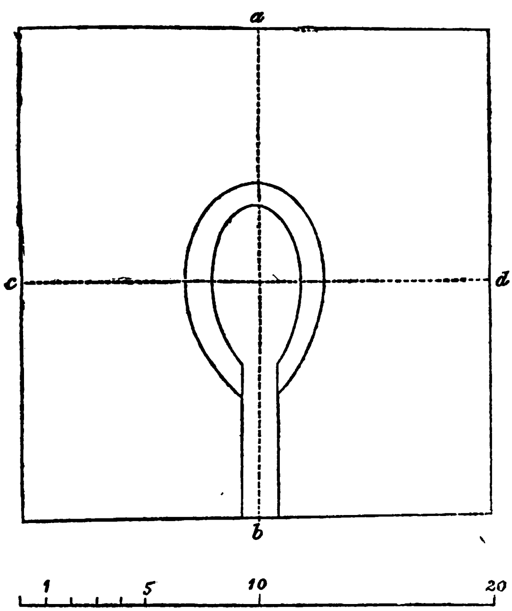
The site chosen for a kiln, will, if possible, occupy a hill side near the quarry; an excavation is made, proportioned to the size of the kiln, which will reduce the expense, of masonry, at the same time that it affords the greatest facility for charging the kiln. The body of the building may be composed of any convenient rock, but the interior must be lined with some fireproof material, such as the friable sandstones of the millstone grit, or of talcose slate, where it occurs.

Fig. 8, represents a slightly modified plan of the form of

kiln used on the Schuylkill, Philadelphia, for burning lime with wood.

Plan of Kiln.

FIG. 8.



This is a plan of the foundation. The oval in the centre is the opening of the kiln, and the space between the lines represents the offset upon which the arch of limestone is turned, and will appear more plainly in the vertical section, Fig. 8, *b*.

The size of this opening may be ascertained from the scale. As it widens upwards, the oval is altered to a circle, so that at the top the opening is circular.

Front of the Kiln.

FIG. 8, *a*.

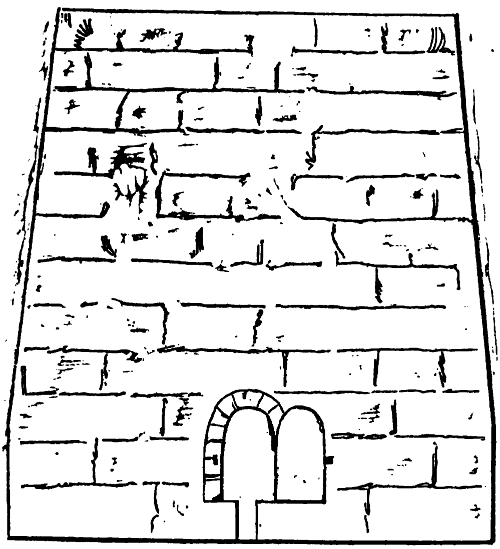
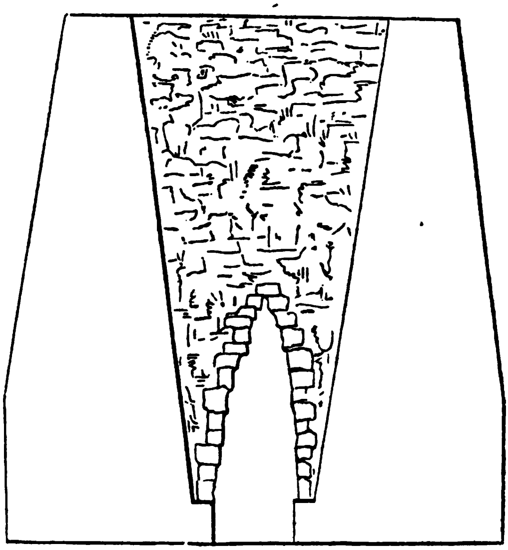


Fig. 8, *a*, represents the front wall of the kiln, with the door of the fire-place open; when this is shut, air is admitted through the narrow space below the door.

When the kiln is built, the filling commences by the construction of an arch formed of the stones to be burned, each one slightly projecting over the preceding, till they meet on all sides at the top. It is obvious, that, as this process goes on, the back must be completely filled, otherwise, the arch cannot stand. When this is completed, the loose stones are thrown in till the kiln is filled, when it is ready for firing.

Vertical section of Kiln.

FIG. 8, *b.*



This cut represents a vertical section of the kiln on the line *c*, *d*, of *fig.* 8, that is, a section parallel with the front wall. It shows the appearance of the arch after the kiln is filled and ready for firing. The height of this arch will appear from the scale on Fig. 8. It is necessary that the space included by it should be sufficient to contain a large fire. In front, the arch rests against the wall, as seen in the following cut, which represents the fire-place in the longest direction. The construction of the arch of loose limestones, is the only operation that requires any skill, in the filling of the kiln. The firing is commenced gradually, but may afterwards be urged rapidly, and of course must be continued, without intermission, to the end of the operation.

Vertical section of Kiln.

FIG. 8, *c*.

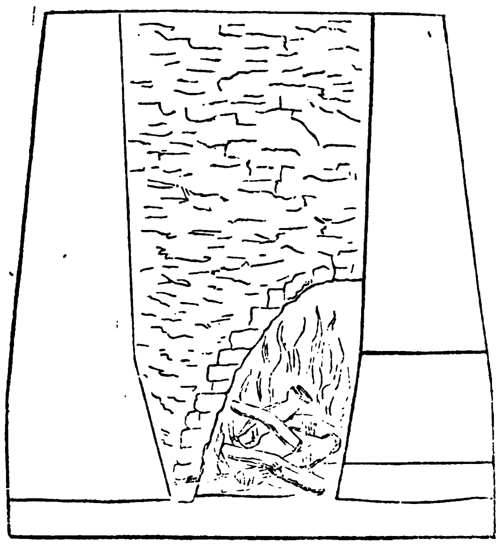
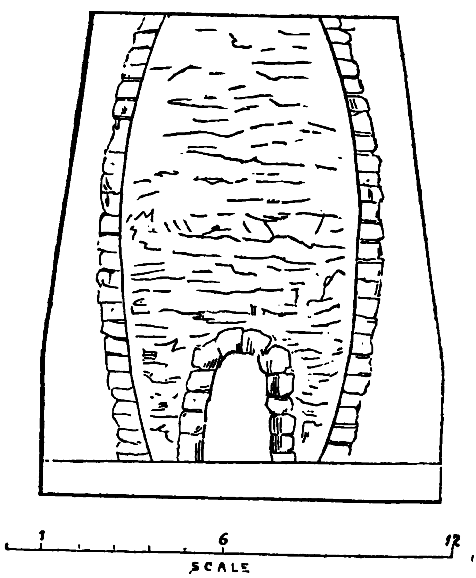


Fig. 8, *c*, is a section at right angles with the preceding, or on the line *a*, *b*, of *fig*. 8. It shows the manner in which the fire is made, as well as the appearance of the arch in that direction. The capacity of this kiln is about 1000 bushels. It is usual to wall up the door-way with loose stones, leaving barely space enough to admit the pieces of fire-wood. The space within is kept well supplied with fuel, and the door is closed after each firing, so as to admit as little cold air as possible above the fire. The air necessary for combustion enters below, passes through the fire, and is consumed. I mention these facts, which, although sufficiently obvious, appear to be neglected; our common kilns rarely have any doors, or other means of preventing

the loss of heat from a current of cold air rushing through the kiln. Although the fuel used in this kiln is wood, its form is not that which is best adapted to that species of fuel. Where wood is the fuel used, the opening of the kiln should be contracted at top. But for coal it should be wide, as in the plan just described. For a perpetual kiln, the latter requires some modification; the bottom should terminate in a cone, where there must be an opening large enough to admit a shovel, and one or two air-holes, a few feet higher, are required.

Section of a New Hampshire Kiln.

FIG. 9.



This is a section of a kiln for wood, in use in New Hampshire. The section supposes the front wall removed, and represents the form of the arch as it rested against the wall. This is the

form best adapted for wood, and will answer well for an experiment with us. It is smaller than the preceding, more simple in its construction, and will cost much less. It will, notwithstanding, be a vast improvement, in both time, labor, and fuel, on the rude kilns now in use.

Vertical section of Kiln.

FIG. 9, *a*.

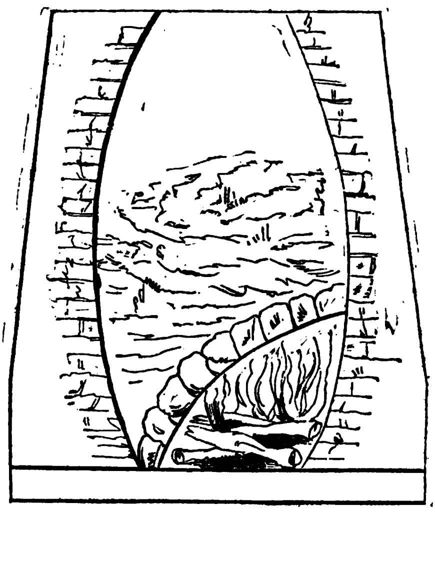


Fig. 9, *a*, is a section in the opposite direction, showing the manner of constructing the arch, and the fire-place. After what has already been said, these sections require no further explanation.

It is very curious to observe the primitive mode of quarrying, practiced by the lime burners of certain parts of the State. Fires are kindled upon the exposed surface of the rock, until

fragments separate from the mass by expansion; an effect sometimes hastened by the application of water.

Two hours work of one man, and an ounce of gunpowder, would have accomplished more than the labor of two men a whole day employed in this process.

The limestone for charging the kiln must be broken into fragments, of about three or four inches in diameter. Moist stone just from the quarry is more easily calcined, than when it has been long exposed and dry. The time required for the calcination varies with several circumstances—the nature of the stone, the quality of the fuel, &c.; but the workmen soon learn from experience the proper time to arrest the firing, for the lime, when thoroughly calcined, gives out a peculiar white light.

A shed should always be provided for the protection of the lime from the weather. In Philadelphia, the lime-burners save some labor, by using two adjoining kilns; whilst one is burning, the other is cooling, and the lime is allowed to remain in it till sold, and this alternation is kept up. But this need only be practised when the lime is not barreled.

Of the value of lime, as an article of commerce, it is needless to say any thing, yet it seems unaccountable, that not a single market, of any importance, between this and Baltimore, is supplied with lime burned in the Southern Atlantic States; the whole region being supplied, principally, from Maine. Lime burning is a process, too, that requires, comparatively, but little of capital, skill, or experience.

I append some statistical information, from which the profits of the business may be gathered. From Dr. Jackson's report on the geology of Maine, (1837) it appears that 400,000 casks of lime were exported from Thomaston that year, at an average price of $1 per cask; and the cost of production was as follows:

Rock at the kilns costs 20 cents per cask....	$80,000
Wood, 40,000 cords, at $3......................	120,000
Labor in burning................................	40,000
Casks, 400,000, at 28 cents......................	112,000
Cost of 400,000 casks of lime................	$352,000

This lime is distributed along the coast, from New York to

New Orleans, and the trade even extends to the West Indies. In the State, all taken together, the amount of lime sold amounts to 700,000 casks, which is an important item, exclusive of the employment afforded in the transportation of the lime to distant ports.

Expenses of burning 100 *tierces of Lime at Franconia, New Hampshire.**

"Cost of quarrying and hauling	$41
Breaking and filling in	6
Filling out	10
15 cords of wood, at	15
Labor	7
100 tierces, at 42 cents	42
Interest, and incidental expenses	5
Cost of 100 tierces	$126

The burning requires four days and three nights. Three men are employed."

Cost of burning 600 *bushels of Lime in South Carolina.*†

"Quarrying, &c.	$12 60
Hauling	5 00
Filling kiln, &c	10 00
22 cords of wood	10 90
Hauling wood	6 60
	$45 10"

"*Estimate of Mr. Write, who burns Lime under the lessees of the Dexter Rock, Rhode Island.*

For the rock in ledge, for the use of kiln, and for steam engine for pumping water from the quarry	$150 00
Expense of getting out water prepartory to quarrying rock	40 00

* Jackson's Report. † Ruffin's Report.

Cost of quarrying $50, and hauling rock out of pit $40,	90 00
Drawing to and filling kiln	40 00
Tending kiln $26, filling out $30	56 00
Pointing kiln	5 00
540 casks, at 45 cents	243 00
75 cords of wood, at $5	375 00
Carting to Providence at 20 cents	108 00
	$1107 00
540 casks of lime sell for	1260 00
Profit in quarrying and burning	$153 00

Seven turns of 24 hours each—two men employed at $13 each for burning a kiln of lime."

Perpetual Kilns.

" Estimates of expenses and profits in burning lime by means of small anthracite coal, in a perpetual kiln, owned by Mr. Curtis, in Boston, the lime rock being brought from Thomaston, Maine, and costing 50 cents per cask.

26 casks of lime rock at 50c	$13 00
2 tons anthracite coal at $3 per ton	6 00
Labor of three men at $1	3 00
Labor of one horse to raise rock to kiln	50
Interest on cost of kiln, $900, 15 per day	15
	22 65
26 old lime casks at 12½ cents	3 25
	25 90
The lime sells at $1 12 per cask	29 12
Daily profit	$3 22

"There is a perpetual kiln in Charlestown, owned by Mr. Gould, who burns Thomaston and L'Etang limestone by means of anthracite small coal. I visited this kiln, obtained a plan of it, and learned the following statistics through the politeness of Mr. Gould."

The kiln [which is an excellent one] cost $900. It is built of Charlestown clay slate, and is lined with red sandstone. It

is 19 feet high, 11 feet across the top inside, 12 feet wide at the boshes, (the widest inner part near the middle of the kiln) and two and a half feet wide at the hearth.

Interest on cost of kiln, $900, at 6 per cent. per ann,	$54 00
Two and a half tons of coal per day, per year......	2250 00
9000 old casks at 12½ cents......................	1125 00
Lime rock for 30 casks per day, at 50 cents per cask, per annum................................	4500 00
Labor, 1 foreman at 35 per month, and 2 laborers at $1 per day..................................	1020 00
Use of horse for hoisting lime rock and carting expenses, 50 cents...........................	150 00
Cost per annum for 9000 casks of lime............	$9099 00

Therefore, each cask costs the manufacturer $1.011.
If the lime sells for........1.125
Deduct cost..............1.011

Profit per cask, cents......$1.14
Or on 9000 casks, $1026, for one year's profits. Or if the lime sells for $1 25, $2121 per annum."

Cost of burning 1000 *bushels of Lime at Philadelphia.**

" Limestone, 66.6 at 85 cents..........................	$56 61
Oak wood, 15 cords, at $3..................................	45 00
Hire of 2 hands 4 days at $1............................	8 00
	$109 61

Cost of 1000 *bushels, when coal is used, at the same place.*

Limestone...	$56 61
Coal, 10 tons, at $2..	20 00
Hire of 2 hands 2 days, at $1..............................	4 00
	$80 61

* Ruffin's Report Ag. S. C.

*Estimates of Lime-burning in Rhode Island.**

"Estimates of the expenses and profits of lime-burning at Harris Rocks; the manufacturers owning the quarry. Estimate for 350 casks of lime:

Quarrying the limestone $50, carting $25	$75 00
Attendance on kiln $20, and filling out $12	32 00
40 cords of wood at $4 50	180 00
350 lime casks at 45 cents	157 00
Carting to Providence 20 cents	70 00
Rent of kiln	20 00
	534 00
350 casks of lime sell at Providence at $2 net	700 00
	534 00
Leaving profit in burning and value of rock	165 50
The rock would sell at 12½ cents per cask in ledge, hence deduct	43 75
Clear profit in quarrying and burning 350 casks of lime	$121 25

"*Expenses and profits in burning the hard rock of the Middle Hill.*

Quarrying $35, carting to kiln $25	$60 00
Attendance on the kiln $20, filling out into casks $15,	35 00
35 cords of wood at $4 50	157 50
450 casks at 45 cents	202 50
Rent of kiln	20 00
Carting to Providence at 1 shilling per cask	75 00
	$550 00

* Jackson's Report Geol. Rhode Island, 1840.

400 casks lump lime, netting in Providence 10s.		$666 67
40 " ordinary lime, netting 7 shillings,	-	46 67
10 " first quality lime, netting 12 shillings,		20 00
		733 34
		550 00
Value of rock in ledge and burning profit,	-	183 34
Rock worth in ledge 10 cents,	- - -	45 00
Net profit,	- - - - - -	$138 34

The following remarks on the limestone of the Southern tertiary formations, by J. T. Hodge, Esq., are taken from the Trans. Ass. Am. Geol. and Nat.:

" In Chester county, Pa., while on the geological survey of that State, I have seen lime made and sold for *ten cents* a bushel, where the natural facilities are no greater than here. And when on the same business in Maine, and employed at Thomaston in obtaining statistics of the lime business, I came to the conclusion, that the Southern States must be remarkably deficient in limestone; that notwithstanding the difficulties the Thomaston people had to contend with, in the high price of fuel, a bad harbor, that frozen up one-third of the year, and their remoteness, still they managed to monopolise the lime business of the Atlantic coast, of the Gulf of Mexico, and up the Mississippi to Natchez. The average cost of a cask of lime at the wharves at Thomaston, was, as near as we could estimate it, about seventy cents, and this included twenty cents for the cask. But, unfortunately, the term "cask" represents no definite measure. By law it should hold "forty gallons," five bushels, but every mason of whom I have made inquiries, and who has measured them, says their capacity is continually changing; that most of them contain *less* than a common flour barrel, and that *three bushels and a half* is probably near the average measure of their contents. Their large size is made up by enormously thick staves, and heads about an inch thick, and frequently large empty spaces remain in the cask. Yet, for this meagre amount of lime, the people of South Carolina are willing to pay a sum for which they themselves might make full

eight times as much; and by thus rendering it cheap, the labor lost to their favorite crop would not be missed, when thereby a bale of cotton to the acre would not be considered a maximum product, nor *two* ears of corn to each of the widely separated hills, a subject worthy of remark.

"The prejudice of workmen—their not liking to use a different material from what they have been accustomed to—is one reason why the Thomaston lime has successfully competed with all other lime made on the Atlantic coast. The name of that is favorably known, and deservedly so, and it will sell, when another equal to it, from another locality, will not bring even a very inferior price. There was a remarkable instance of this a short time since in New York, some excellent lime from Rhode Island hardly finding a market at any price. Most of the Pennsylvania lime contains magnesia, and yet celebrated as is the Philadelphia mortar for whiteness and durability, and as are the fine farms of Chester and Lancaster counties, which are enriched almost entirely by lime, there is a universal prejudice against magnesian limestones. But this cannot last."

The facts that I have here presented, will enable those that examine them, to judge, how far it may be to the interests of the State to continue to import lime from Maine, or to burn it for themselves. It will certainly be anomalous if it should appear, that we who have fuel almost at the cost of hauling, and limestone literally at $1 25 per acre, should not be able to supply our own market with this indispensable article.

Hydraulic Limestone.

I have already stated, that we have the group known in New York as the water limestone, and investigations at present in progress will settle the existence of the cement in the State.

Sulphate of Barytes.

Two veins of this mineral, a foot or two in thickness, occur among the limestones of the valley—one near Pratt's Ferry, and the other above Elyton. This mineral is ground, and sold as a substitute for white lead for paint; it is also often mixed with that substance fraudulently, as it can be obtained at a far

less cost. It is only detected, when so mixed, by chemical analysis. Both of these beds are very pure, and would answer well for paint.

Flagging Stones.

The qualities requisite to constitute good flagging stones are the following: They should split readily, so as to require but little dressing; they should be sufficiently hard, to resist the wearing forces, to which they are subjected; should absorb water but slightly, and not be subject to exfoliation from changes of temperature.

The flags of the coal measures answer all of these conditions, but they require much care, and a considerable degree of skill in the person who selects them. For where they are improperly chosen, they possess few, if any, of the qualities enumerated above.

The yellow sandstone of the Red Mountain group, to which I have so often referred, answers all the requirements of excellent flagging stones, in a pre-eminent degree. The lowest point at which I have seen this rock, is at Green's, where it occupies a narrow ridge, a favorable position for a quarry. It is also found at Bucksville, west of Dr. Davis's. It may be traced all the way to St. Clair Springs. There is no material in the State, that equals this for ordinary flagging. It is probable that beds will also be found near Pratt's Ferry, on the Cahawba.

Grindstones.

Materials for these abound at the localities of flagging stones just described; they are said, by those who have used both, to equal those that are imported. On the head waters of Hurricane, amongst the coal measures, excellent grindstones are occasionally manufactured. Nothing can show more forcibly the difficulty of turning trade from its established channels than the fact, that with this knowledge, we still continue to import grindstones from Nova Scotia.

MILLSTONES.

The stratum of conglomerate that occurs in St. Clair, is remarkably well adapted to this purpose; it is about 18 inches thick; a parting of red clay separates it from the underlying rock, so that scarcely any quarrying is required, excepting what is necessary in the splitting out of the pieces of the exact shape; and even this is greatly facilitated by the joints that intersect the rock. Its mineral composition is also quite favorable, being a cement of silica, with white quartz pebbles closely enveloped in it. The fracture is rough, and almost hackly. Including all the circumstances, it would be difficult to find a locality equal to this.

ALUM.

Wherever the black shale is undergoing decomposition, and not exposed to the washing of the rains, it will be found coated with sulphate of iron, and sulphate of alumina. The cause of this is simple, the shale abounds in sulphuret of iron; the sulphur of this mineral, by its reaction with the oxygen of the atmosphere, forms sulphuric acid, which combines with the alumina and iron.

The greater part of this shale is sufficiently bituminous to ignite, and if it were collected in a large heap and burned slowly, the ashes would contain these salts, and might be separated by lixiviation and evaporation. As alum is a sulphate of alumina and potash, if the potash were not present in sufficient quantity, it could be added. These are the simple principles involved in the manufacture of this useful salt.

TRIPOLI.

There is a light porous substance, to which I have already alluded, found in the limestone caves of the State, that resembles Tripoli. I have placed some of this in the hands of artists, who pronounce it equal to that mineral for polishing metals. It is quite abundant in these caves. I have specimens from Talladega, and there is a cave above Elyton, called Chalk cave, from the occurrence of this substance.

MINERAL WATERS.

The mineral springs that flow from the silurian rocks, are both saline and sulphurous. The most important and best known are Blount Springs. These have been so long and so frequently visited by the citizens, that they require no description. They have moreover been analysed by Professor Brumby, and his analysis has been recently republished and widely distributed.

One fact is remarkable in these springs—they are situated in precisely the same geological position as the celebrated springs of Virginia, which are connected with anticlinal axes. In the same valley, there is another spring near Brooksville, above Blountsville.

The St. Clair Springs also occur in a similar position. A bold limestone spring rises a few yards from the place, and along the elevated ground on the banks of the stream flowing from this, numerous mineral springs burst forth around the hill upon which the houses stand. The principal, and the only one examined, is situated towards the east, alongside of a bed of magnesian limestone. Besides its being highly sulphurous, I found in the water, on a hasty, and consequently imperfect, examination made on the spot, salts of lime, magnesia, and soda, in valuable quantity. To make any thing like a thorough examination of the springs of Alabama, not already examined, would require more time than was devoted to the entire survey.

This spring is situated in a healthful region ; the proprietors are improving the grounds and buildings, and making it otherwise a pleasant place of sojourn for the summer.

The Shelby Springs, like those of Blount, are situated near the black shale. One issues from the limestone, and is calcareous, and the other from the shale, from which it derives its sulphurous and chalybeate properties. This has also been analysed by Prof. Brumby. The situation is beautiful, and the establishment is arranged with a view to both taste and comfort.

I am not quite certain as to the geological position of the Talladega Springs; but of the qualities of the water, judging from Prof. Brumby's examination, there can be no doubt. There are many other springs in the State of deserved reputa-

tion, of which I have not yet collected the materials to give any account. Enough is already known, to make it evident, that the citizens of Alabama need not leave the State in search of more valuable mineral waters.

Soils.

As soils result from the disintegration of rocks, through atmospheric agencies, it is obvious that natural soils will be fertile or barren, just in proportion as the rocks contain in their components, those ingredients that constitute the basis of fertility. The principal inorganic elements of soils are silica, lime, alumina, magnesia, potash and soda, and no soil can support vegetation, that does not contain more than one of these; and hence a soil derived from a rock composed of a single mineral, must be barren. This is every where exemplified; the barren ridges of hornstone running along parallel with the fertile valleys at their base, are good examples. It has been shown that the rocks of the Red mountain group are made up of calcareous, argillaceous, and silicious rocks, that contain in their composition all the elements of fertility, the calcareous rocks generally occupying the bottom of valleys, and the others the slopes of the hills on each side. Every shower of rain brings down from the hills the debris of the rocks, mixed with decaying organic matter, and hence the source of the fertility of the soils of this region. In Shelby and Benton, where these rocks occupy a considerable space, their influence upon the soils is too plain to have escaped the notice of any one who has passed through that country. The long, poor, silicious ridges of cherty rock and sandstones, covered with pines, and the intervening fertile limestone valleys, are through the whole district, quite conspicuous.

In Jefferson, Blount, Shelby and St. Clair, the contrast between the soils of the silurian rocks and those of the coal measures, is every where striking. Few regions are more highly favored in relation to soil, climate, and water—the profusion and great beauty of the springs are proverbial. A full consideration of the nature and resources of the soils of the State, must be reserved for a future report.

CHAP. IV.

Extent—Mineral composition and structure—Calcareous beds—Millstone grit—Coal measures—Extent—Structure and mineral composition—Coosa coal field—Cahawba coal field—Warrior coal field—Economical relations of the carboniferous system—Improvement of the rivers—Comparative value of coal as fuel—Carbonate of iron—Flagging stones—Millstones—Fire-proof stone.

Extent.—I have not yet been able to designate precisely the limits of this system, for, although that portion of the State colored blue on the map is occupied principally by the carboniferous limestone, yet the silurian rocks are no doubt in many places laid bare where I have not seen them. For instance, I have been informed by Dr. Lovell, of Athens, that the black shale is found on the surface in Limestone county, and it is, I believe, also exposed on Flint river, Madison county. To construct an accurate geological map of the State, although a work of no great difficulty when the geological formations are once identified, yet is one requiring more time, than has yet been devoted to it. In general, at present it may be stated, that all that part of the State above the lower falls of the rivers, and not already described, as belonging to the Red mountain group, is covered by the rocks of this system; they are therefore the most prominent rocks in the State, other than the cretaceous formation.

Mineral Composition, and Structure. — Whatever doubts may exist elsewhere, regarding the horizon of the carboniferous rocks, there can be none in Alabama. The millstone grit and coal measures rest unconformably upon the Red mountain rocks on the west, and where the carboniferous limestone makes its appearance at the southern extremity of the system, it is separated from them by a thick stratum of sandstone, resembling the millstone grit, and every where, the carboniferous rocks are either horizontal, or in-

clined at a very small angle, while the silurian rocks are always either vertical, or dipping at an angle which is seldom less than 40°.

CALCAREOUS BEDS.

The greatest development of the calcareous rocks, of the system under consideration, occurs north of the Tennessee river, where they enter Alabama as prolongations of the Cumberland mountains.

In the upper part of the State, between the Racoon mountain and Huntsville, a number of streams, tributary to the Tennessee, rise in the Cumberland mountain, and find their way to that river, through long narrow valleys, excavated in these rocks. The valleys are separated by equally long straight ridges, that extend like a fringe from the southern extremity of the mountain; these are separated by so narrow an interval, that standing on the top of one of them, a bird's-eye view may be taken of the adjoining valleys, with their numerous farms, and houses snugly sheltered under the mountains. These valleys open into the great valley of the Tennessee; and to enter them, or go from one to the other, it is generally necessary to pass around the spurs, as they slope off towards the river.

Bolivar, in Jackson county, is a good point to commence the examination of the geological structure of the Cumberland mountain, which is cut to its very base by the river and the streams to which I have alluded; and as the sides of the mountain ridges expose the naked rocks, excellent sections from top to bottom may be obtained.

I saw at Mr. Charles Jones's, a reddish mottled limestone, which, in the absence of fossils, I was unable to refer to its proper geological position. If it belong to the carboniferous rocks, it must occupy a very low place in the series, and I have not met with it elsewhere. It is, I think, identical with a bed worked as marble at Winchester.

Along the base of the mountain north of Bolivar, the rocks are characterized by the remarkable coral to which Leseur

gave the name of Archimedes,* from its resemblance to the screw known by that name. It is whiter than the weathered surface of the rock upon which it appears, and is therefore always conspicuous. Above this is a thick bed of softer, and more argillaceous limestone, containing numerous pentremites; and this is followed by beds of blue limestone. The next stratum, which is about four feet thick, is a fine argillaceous slate, destitute of fossils; and above this is a heavy bed of magnesian limestone, of a light color, and very hard. At the point where I examined the mountain, this is the next rock below the coal measures, which are here 20 or 30 yards in thickness, and contain a workable bed of coal. The millstone grit can scarcely be recognised here, and the coal measures are reduced to a mere strip on the crest of the mountain. In consequence of the washing of the limestone, the former are constantly falling down, and hiding the underlying rock. The ruins thus accumulated, often slide down in wet seasons, carrying with them whole acres of the mountain side, with the forest trees, undisturbed as they grow.

The section at this place is repeated in all the valleys, excepting, that at the base of some of the mountains, I observed another stratum of magnesian limestone. The line joining the sandstones on the top, and the underlying limestone is marked by the termination of the cedars which clothe the sides, wherever the latter rocks occupy the surface. And in this way the existence of the coal measures above, may be ascertained without actual examination.

After leaving the broad coal fields of the Warrior and Cahawba, it was curious to observe the narrow strips of coal measures on these mountains, which had the appearance of huge coping stones placed there for the protection of the limestones

* This fossil is now, I think, referred to Mr. Lonsdale's genus *Fenestella*, and will for the future be called *Fenestella Archimedes*. The screw is the axis around which the coral seems to revolve; it is rarely more than half an inch in diameter, while the expanded portion of the coral is often six inches wide. The direction in which the coral revolves around the axis is not uniform, some being dextral and others reversed, a fact pointed out to me by a youth, the son of Mr. Charles Jones.

below. On the ridge between Racoon and Crow creeks, the sandstones were wasted to a breadth of a few yards, at the same time that they form a vertical escarpment. And where they spread out into a plain of some acres in extent, as on Broad Top, near Huntsville, after ascending from the limestone country below, the contrast is most striking, so different are the soil and growth from all around.

A remarkable feature in all the carboniferous limestone region is the occurrence of caves, from which issue bold streams of limpid water. Some of these are ingeniously dammed up at the mouth, and furnish motive power to mills.* A remarkable spring occurs at Huntsville, which, besides affording an abundant supply of excellent water, furnishes power sufficient to raise it into an elevated reservoir for the use of the city.

Deposits of earth, from which nitrate of potash may be obtained, are common in all these caves. Passing on the west of the Cumberland mountain, along the valley drained by the streams that flow into Flint river,† lower strata of limestone are exposed than any that I saw in Jackson. The cherty rocks become more conspicuous towards the base of the mountains which assume a greater height. Mount Sano, Round Top, and the other little mountains that rise above the beautiful country around Huntsville, present admirable sections 1000 feet in thickness of these rocks. The strata are all horizontal, or nearly so, and the alternation of softer beds which are washed away, leaving the harder strata projecting, produces a series of terraces that extends around the mountain. Half way up the mountain, there is a stratum of sandstone four feet thick, the surface of which is covered with *Stigmaria ficoides*, the usual accompaniment of coal; but as there is limestone overlying this, and directly in contact with it, if coal ever existed, it was washed away before the deposition of the limestone. Cor-

* A subterranean mill-pond struck me as a novelty.

† I saw some black shale here, which may belong to the silurian system, but the state of the water prevented further examination.

als, pentremites, and the shells of numerous species of mollusks are found in these rocks.*

On the tops of some of the mountains around Huntsville, a bed of limestone of oolitic structure is found. I saw it also on the upper surface of the limestone on the eastern side of the Lookout mountain. Rock of this structure, however, is not confined to the top of the series, but may often be seen in the cherty rocks, towards the base. This is the source of the oolitic pebbles, to be described hereafter, that are found rounded and water-worn, on the surface in the lower part of the State.

Near Ditto's Landing, off the river, high ridges are seen to the right, and off the turnpike road, where the whole series can be examined. At this place I saw a drab colored limestone, with black and deep yellow spots. Notwithstanding the mountainous and broken character of the country, I did not find in the whole region, a single anticlinal axis; the strata are horizontal, and undisturbed, and may be traced from mountain to mountain in the same plane. The influence of the uplifting east of the Tennessee did not reach far west. The whole country seems to have been lifted up bodily; every thing presents the appearance of repose; fossils are for the most part found with valves in juxtaposition, and pentremites in great profusion occur; some seem to have been buried as they stood,

* When I first saw this, I supposed that it slipped down from the coal measures on the top, but further examinations, elsewhere, have satisfied me that it is in place. Remains of it may be seen on all the mountains.

A fine collection of the fossils of the carboniferous rocks about Huntsville, I had the pleasure of seeing, in Dr. Newman's cabinet, and among them the teeth of a sauroid fish. The Doctor was polite enough to allow me to make a sketch of these on the spot, which was shown to Professor Agassiz at the meeting of the American Association of Sciences in Charleston. He pronounced the teeth at once to be those of the genus *Cladodus*, a genus hitherto only found in the carboniferous rocks of Europe. Geologists will be glad to learn, that through Dr. Newman's labors we have this additional evidence that our rocks are the true equivalent of the carboniferous limestone of Europe. There are other remains of fishes found around Huntsville: among these the teeth of Psammodus may be distinguished by their bluish color and punctated surface. Psammodus is also peculiar to the carboniferous limestone.

erect with arms and tentaculæ expanded, others are folded up, and many are found reclining with stems not dislocated, on the surface of the rock.

The strata of coal measures are equally undisturbed, and very generally enclose a seam of coal; that on the summit of Round Top is about 15 inches, and the shale encloses lenticular nodules of carbonate of iron. Every thing shows that the strata were once continuous, and that the hills and valleys are the result of denudation. The rocks extend west, into the adjoining counties; a portion of the State reserved for future exploration.

South of the Tennessee river, they are seen emerging from under the millstone grit along the valleys. In Brown's valley, extending from Gunter's Landing through Marshall, thence through Blount, to its southern boundary. Along this whole distance, they dip east and west very gently, but sink gradually after crossing the Tennessee, and disappear altogether, beneath the coal measures, about four miles below Blount Springs.

The stratum of sandstone mentioned as occurring half way up the mountain at Huntsville, now rests upon the silurian rocks, in heavier beds, and more like the millstone grit; so that at Village Springs, and Blount Springs, the limestone has lost one half its thickness. And still farther south, the superincumbent limestone disappears, whilst this powerful stratum still remains, and rises up boldly from the base of the true millstone grit, with a greater dip, and leaving an interval between the two. This rock forms the ridge that runs parallel with the sand mountains on both sides of the valley.

Blountsville stands upon the carboniferous limestone, which may be studied on all sides of the village. A few miles south, some remarkable caves occur in this rock; one belongs to that class called blowing caves, in which the air takes an opposite course at different seasons of the year, blowing outwards in summer and inwards in winter.* These caves are all due to

* The cause of this phenomenon is simply this: two openings occur at different levels in the cave, which communicate with the external atmosphere. In winter the air of the cave is of a higher temperature than that without, it therefore rises through the opening, and the outer air rushes in, is heated, and escapes like the rest; but in summer these conditions are reversed, and with them the current.

fissures in the rock, which are enlarged by the water flowing through them. Some of these caves were used by the aborigines as burial places, and their remains are yet found in them, with fragments of lead,* mats, shells and trinkets.

After leaving the Tennessee river, fossils become rare, with the exception of *Fenestella Archimides*, which characterizes this rock wherever it is found. Along the main valley, Village Springs is the lowest point at which it is seen. South of this, the millstone grit rests upon the silurian rocks. At the base of Lookout Mountain, west of Ashville, it occurs in thick beds, having as usual the limestone with oolitic structure, on top; this continues upwards through the valley, and into Georgia. The fossils of this formation have been collected, but have not been identified with sufficient certainty to have a list presented here.

Millstone Grit.

This formation is made up of powerful beds of quartzose conglomerate, and white silicious sandstone. The former is used wherever it occurs for millstones, and hence the name; the sandstone, or grit, differs from that of the coal measures, in being composed almost entirely of quartzose grains, cemented together, and rarely containing scales of mica. This formation may be traced as low down as the Hill settlement; the road to Scottsville passes over it. It is here, however, a low ridge, but upwards, it rises gradually like the carboniferous limestone, till it appears in the escarpment on the east side of Racoon mountain, 250 or 300 feet in thickness.

It would be useless to mention all the points at which I examined this rock; suffice it to say, that it is the foundation upon which the coal measures rest, and that wherever they are tilted up, there does the millstone grit make its appearance. It can be best studied along the valley of Shades creek, west of Elyton, entering the valley where the road from Lacey's ferry crosses the ridge. This is the western edge of the coal field of the Cahawba, and vast overhanging ledges of rock are found,

* These have suggested to the people lead mines at these places.

at the foot of the escarpment, on the lower surface of which coal plants of large size, often three or four yards in length, have left their impressions. Masses of the rock, the size of ordinary houses, have fallen down, and strew the hill-side. Almost the only really wild and rugged scenery in this part of the State, is found, where the millstone grit ridges are cut in two by the streams. The valley of Turkey creek at Hanby's mills, Cunningham's creek, and the Shades creek, where it bursts through the ridge, are fine examples. The gorge through which the Warrior passes near Village Springs, presents a scene well worth a visit.

The only elevation in the State that presents any thing approaching the impressive grandeur of a mountain, is the enormous ridge of millstone grit, called Lookout mountain.

Coal Measures.

These rocks, which rest upon the millstone grit, are made of a series of beds composed of conglomerates, sandstone, shale, and beds of coal, the thickness of which has not yet been ascertained.

Extent.—I have shown that the little patches of measures on the tops of the mountains in Madison and Jackson counties, were once continuous; the same appearances are observable in Morgan and Marshall counties, where the hills, after ascending from the river, are capped in a similar manner with sandstones and shales enclosing beds of coal.

The Racoon and Lookout mountains present on their summits plains of coal measures of considerable extent. These connect themselves with the measures of the Locust Fork of Warrior, and the Cahawba, whilst the isolated patches on the hills in Morgan and Lawrence, run into those of the Sipsey and Mulberry Forks. in such a manner as to leave no doubt of their being parts of one continuous and vast coal field. How this has been broken up, will be explained further on.

At present, I know of no better way to designate for reference the divisions of the coal formation of the State, than by the rivers by which they are drained. According to this classification, the St. Clair coal field will belong to the Coosa, although it is connected on the southwest with the Cahawba.

This little coal field is on the eastern flank of the low mountain range that extends from Springville to Ashville; it contains about 150 square miles.

The Cahawba coal field is pretty well defined; on the south and east, it is bounded by Little Cahawba and its tributary, Shoal creek. It reaches within two miles of Montevallo, and on that side of the Cahawba, becomes narrower till it reaches within three miles of the river at Lacy's ferry, from thence it continues upwards a narrow strip, till it joins the Coosa coal field. On the east it is bounded by the Shades creek, as low as Bucksville, from whence the coal measures extend to Shultz's creek. It contains nearly 180 or 200 square miles.

I include in the Warrior coal field, all the region drained by that river and its tributaries. On the west it has been traced beyond New Lexington, in Tuscaloosa county, and coal is found at the source of Sipsey river, in Marion. The whole of Walker, and a very considerable portion of Blount, Jefferson, and Tuscaloosa counties, are covered with coal measures. The area of the Warrior coal field, so far as it is at present known, covers a space of 5000 square miles. So that the productive coal measures of the State are known to occupy an area of 5300 miles. I have not included those of De Kalb, Morgan and Lawrence, nor those north of the Tennessee, because they have not yet been sufficiently explored to ascertain whether they belong to the productive carboniferous rocks. That their limits will be greatly extended by future investigations, no one can doubt.

Structure and Mineral Composition.—From what has already been said, the structure of the coal fields of the State will be readily understood. The usual term, coal basin, does not in any proper sense apply to them, for they are not disposed in circular or oval hollows, but in long, and sometimes narrow, trough-like depressions, through which the principal streams of the region flow. To understand the cause of this, it will be necessary to take a glance at the principal anticlinal axis of the State. It was shown that the carboniferous rocks have been lifted up in three lines of unequal length; the principal of these extends from the N. E. corner of the

State to Centreville: on the east of this the Coosa and Cahawba coal measures are tilted up, and dip south of east, whilst on the other side of the line, the coal bearing rocks of Racoon mountain, the Locust Fork, and those of the Warrior itself, dip in the opposite direction.

The next commences at the head of Murphree's Valley, and unites with the preceding, at Village Springs. On each side of this, the rocks dip east and west; it forms one side of the trough through which the principal branch of the Locust Fork flows. The other coincides with the Tennessee Valley as far as Gunter's Landing, and extends through Brown's Valley in Marshall and Blount. Although the lower carboniferous rocks are not lifted to the surface far south of Blount Springs, yet the influence of this line of uplift, is perceived as low as the junction of the Locust Fork with the Warrior, where the coal measures are barely bent upwards, and dip in opposite directions.

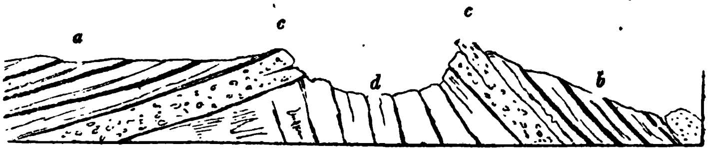
From this simple view of the direction in which the forces acted, that have moulded into their present form the carboniferous rocks, and to which are due the courses of the rivers, and all the physical features of the entire region, there will be but little difficulty in understanding the structure of our coal fields.

The following section, in which the details of the Red mountain group are omitted, represents the relative position of the two principal coal fields of the State, those of the Warrior and Cahawba.

SECTION ACROSS JONES'S VALLEY,

Showing the position of the Warrior and Cahawba Coal Fields.

FIG. 10.



a—Warrior Coal Field.
b—Cahawba Coal Field.
c, *c*—Millstone Grit.
d—Limestones of the valley.

The Warrior coal measures, with the underlying millstone grit, are seen resting unconformably upon the limestones, and showing that although the valley coincides with the anticlinal axis of the coal measures, there is no such coincidence with that of the underlying silurian limestones. It appears that the anticlinal line of the latter rocks lies to the west of the valley, and is covered up and hidden by the Warrior coal measures. It is easy to conceive, that if the coal measures west were removed, that this line may be reached, and this absolutely takes place at the lower edge of Blount, where the silurian rocks are seen for the first time dipping towards the N. W. From this point upwards, through Murphree's Valley, the anticlinal axis of the Red mountain rocks and coal measures coincide.* The valley of the Coosa, immediately west of the Racoon and Lookout monntains, however, presents the western carboniferous rocks resting on the upturned edges of the lower limestines, *fig.* 10. The steep south-eastern dip continues from Centreville on the Cahawba to Rome in Georgia, with surprising uniformity. The same is true of the gentle north-western inclination of the carboniferous rocks.

It would be difficult to find a more striking illustration of the adaptation of the earth's surface to man's wants, produced by the simplest possible means. Had the underlying rocks remained in their original horizontal position, the whole country between the Coosa and Tombigby would have been one monotonous sandstone plain. The coal would have been completely hidden, and no one could have even conjectured the existence of the inexhaustible beds of iron ore below the surface. But the simple pushing up of the silurian rocks has revealed all these, in the most effectual and interesting manner, at the same time that it has intersected the coal measures with valleys of great fertility.

Coosa Coal Field.

This small, but very interesting little field, is an oblong depression, drained principally by the waters of Trout creek, and

* Mr. Powell.

Broken Arrow, which flow into the Coosa below Ten Islands. The coal resembles that of the Cahawba, in having a laminated and sometimes a twisted structure; it is very bright, clean, and free from slate. On Trout creek, the bed exposed is only 21 inches, divided into two seams by a layer of shale six inches. Strike N. E. and S. W., dip N. W. 45°. In the middle of the field the coal becomes thicker; and two beds that I examined on Broken Arrow, were each five feet clear coal; one of these was in an excavation where it was impossible to arrive at the dip, but the sandstones in a stream, a few yards distant, were but slightly inclined towards the S. W. The other, the property of Mr. Wright, outcrops on the side of a little ridge. It is exposed on a stream that flows on the back of the ridge, and it was reached in a well, about half a mile distant.* At the opening made, the roof was good, and a parting of a few inches of soft clay just beneath the coal seemed favorable. The steep inclination of this bed, as well as the structure of the coal, resembles that of the Cahawba, of which coal field it is doubtless a prolongation. This coal has been carried down the Coosa, to Montgomery, where it has been sold at 40 cents a bushel. But what gives it its greatest value here, is its vicinity to a good bed of iron ore, which it approaches within two miles. There are here, then, within a space of a few miles, all the materials for the manufacture of iron—ore, coal, limestone, and fire-proof stone, and on the immediate banks of the river.

The following shows the position of this coal field:

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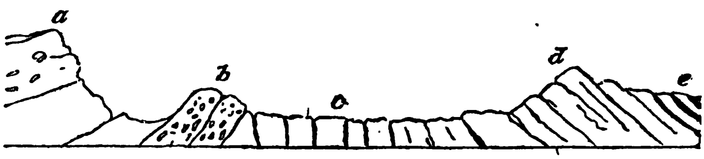
* Operations were commenced at the crop with a degree of skill quite creditable to those engaged, considering that they had never seen a coal mine. As the coal dips *from* the crop, I believe they are now satisfied that an opening must be made at a lower level, in order to drain the mine.

Section across the Valley at Ashville,

From Lookout Mountain to the Coosa Coal Field.

Fig. 11.



a—Lookout Mountain.
b—Bed of Millstone Grit.
c—Silurian Limestones.
d—Red Mountain.
e—Coosa Coal Field.

The millstone grit, which is exposed upon the side of the mountain next the valley, is over 300 feet in thickness; from this locality towards the south, this formation gradually thins out till it disappears altogether before it reaches Hurricane creek, and Pratt's ferry. The same may be said of the carboniferous limestone, that underlies the grit, which thins out at Village Springs, at the upper edge of Jefferson county.

The second ledge of grit seen at *b*, extends from Cunningham's creek upwards, and is found every where in the middle of the carboniferous limestone north of the Tennessee river, as I have shown in the preceding pages.

The rest of the valley is precisely the counterpart of the Red mountains of Elyton and elsewhere. The buff-colored sandstones are, however, more powerful, as may be seen at Greensport, on the Coosa. It will be seen that the Coosa coal field occupies the same relative position as that of the Cahawba.

Cahawba Coal Field.

Above Lacy's ferry, I know little of the coal region of the Cahawba, beyond the fact that coal is found near its source.

At Lacy's ferry, there is a bed about two miles from the river, which is about five feet in thickness. It shows at a point on the hill side, favorably exposed for mining. The overlying sandstone at this place is so full of mica, as very strongly to resemble mica slate.

On the hill side a little lower, and crossing the road, there is a bed of argillaceous sandstone filled with fossils of the genera *Producta*, *Delthyris*, and others, together with a singular plumose *fucoid* plant; as these are all marine remains, they prove very clearly that the waters of the ocean once rolled over the beds of coal on the Cahawba. On the opposite bank of the river, and below the ferry, other seams of coal occur, which I did not examine. On the west side of the river generally, however, above the ferry, the chances of finding coal are few, because the millstone grit runs along parallel with the river, and at no great distance from it.

The geologist who first explores our western forests, and who is obliged to depend for his examinations on natural exposures, together with what his hammer may reveal, will feel at every step how much he is leaving unexamined, that it would be desirable to bring to light. When I first explored the Cahawba, no coal had been raised beyond the quantity necessary to supply the smithies* in the neighborhood; and the thickness of some of the beds, then made known, was ascertained by wading in the water, by which they were covered. Since that time, many beds, the existence of which was only indicated as probable, have been fairly opened, and many others added to those already known.

Near Montevallo, a seven feet bed was examined on a branch of Shoal creek. The strike of the rocks at this locality is N. 40° W., and the dip 50° S. E. Other beds, I have been informed, have been discovered in the vicinity.

On Daly's creek, on the same side of the river, coal has been known for some time. This is probably a prolongation of one of the beds on the west side of the river. Above the mouth of Little Cahawba, there is a long out-crop of coal, in

* The blacksmiths have been, in all parts of the State, the first explorers of the coal beds.

the bed of the river, and which has been traced to the left bank of the river.

At Scottsville, the coal plants in the measures there, give pretty strong evidence of the existence of coal, and lower down at Camp's bloomery at the junction of the coal measures, and silurian limestones, fragments of coal are found embedded in the sandstones. These fragments are rhomboidal, such as those into which coal ordinarily breaks; they show very clearly that they were coal when they were embedded in this rock, and that consequently the sandstone was deposited after the coal was perfectly formed. The rock, with its embedded coal, has very much the appearance of the ruins of a coal seam, mixed with sand, re-deposited, and converted into a solid rock.

On Lewis's creek, and at a considerable height above the river, a bed of two-yard coal is found, which had been excavated on the out-crop, but the coal was not in much repute, among the blacksmiths. It is impossible to judge of the quality of coal from its appearance, where it has been for ages exposed to atmospheric agencies; every one has seen coal so completely decomposed, that when mixed with argillaceous matter, it resembled ordinary clay. And, in general, coal at the out-crop presents that form which miners call dead coal.

On a small stream, whose banks, as it approaches the shore, are precipitous and rugged, and have suggested the name of Little Ugly, two or three beds of great importance occur. Two of these are ten feet or over, and the third is four feet. These are very highly inclined, and will consequently require some skill in the working. The coal is of excellent quality, and preparations are making for its extensive exploration. Good roads have been constructed to the pits, houses have been built for the workmen, and a well executed saw and grist mill erected. Several boats were afloat ready to transport the coal to market, and every thing presented the appearance of well-directed industry. The force at the pits, however, was small, the plan of the mining operations I did not comprehend, and the quantity of coal raised did not bear a proper proportion to the improvements around.

Mining, with us, will be a little precarious, until men are trained to the work; the confinement under ground is so inimical to the free hunter habits of our working population, that

it is no wonder it should seem irksome to them; but after a while they become accustomed to it, for the work is far from being heavy, or uncomfortable, in our thick seams. The problem to be solved here seems to be, the safe and cheap transport of the coal as far down the Cahawba as steamboat navigation, unless indeed some other means of conveyance be resorted to, such as a railroad, which I perceive is already in agitation among our citizens. One thing is certain, that the success or failure of the operations just commenced, will greatly affect the future prospects of this portion of the Cahawba valley. The beds just described are within a short distance of the river. On Cane creek, the next stream above Ugly, there is also coal exposed; but there are others of considerable extent, farther from it; among these, the most remarkable are found towards the source of Caffey's creek. On one of the branches, I found an extraordinary exposure of coal, which extended over a space of two hundred square yards, a circumstance very unusual on the Cahawba. I could only attribute this, to a change in the amount of inclination of the bed, which placed it in a position almost horizontal. I was unable to find the thickness of this bed, but the coal was hard and of good quality, and resembled the Warrior coal in the cubical form of the blocks thrown out.

On the Lick branch of Caffey's creek, I was informed that a bed of two-yard coal occurs.

It is almost certain, that future investigation will show the existence of five or six superimposed workable beds of coal in the Cahawba coal field. It differs from the coal field of the Warrior, in the structure of the coal, which is for the most part composed of bent laminæ closely applied, so that the mass often breaks into fragments that are somewhat globular, and have a highly shining lustre, in the greater thickness of the beds, and in their far greater dip. The Cahawba coal measures have a dip corresponding with that of the silurian rocks, upon which they rest; but I am not yet quite certain that they overlie them conformably. In an economical point of view, the fact, that the field is almost surrounded by iron ore, is highly interesting. On the east, it has the well known ore beds that stretch along from Little Cahawba to Montevallo; and on the west, those of Roup's valley.

The Warrior Coal Field.

The southern extremity of this coal field passes under the beds upon which Tuscaloosa stands. Beds of shale, containing impressions of ferns are found near the old steam mill below town, which is the lowest point at which I have seen the Warrior coal measures. A thin bed of coal was formerly worked near the bridge, and one is now exposed on the Northport side of the river.

A seam of coal 22 inches thick is at this moment worked in the vicinity of the University. The coal rests upon a hard gray under clay, filled with stigmaria; the roof is composed of shale abounding in fossils, plants of the genera *Sphenopteris Pecopteris*, and calamites, overlaid by a heavy bed of conglomerate. The coal is of good quality, and sells readily in town. The first attempt at mining in the State was made here. Although the coal measures are laid bare along the bed of the river, continuously, yet it is only where the streams have washed off the superincumbent beds, that they are exposed, to the right and left. Between the University and Hurricane creek, coal has been raised from one or two thin seams; and in the bed of the creek below Randolph's sawmill, coal comes to view.

After crossing the creek, the coal measures are every where exposed, dipping at a very gentle angle towards the west.* One is immediately struck with the great difference, in this respect, between them and those of the Cahawba. This very small angle of dip is characteristic of the Warrior coal measures, throughout their entire extent; and the effects of it are displayed in the numerous instances in which coal is found at the surface. The inclination of the surface is greater than the dip of the coal, and when this is the case, the latter must be uncovered, and hence the unparalleled number of outcroppings in that part of Tuscaloosa county, lying on the left bank of the Warrior. The country is elevated and broken, and falls

* Although the general direction of the dip is N. of W., yet it is obvious, where beds ase so little inclined, that the slightest local undulation will produce a difference of dip, or even reverse it altogether.

rapidly towards the river, so that there is scarcely a stream that does not display one or more beds of coal. Sometimes the superincumbent shales are removed by denudation, and the coal, for a considerable extent, is merely covered by a bed of loose materials washed from the high ground. By removing these, the coal is reached on the banks of rivulets, and in the bottoms of ravines: and from such localities, Tuscaloosa has been supplied with coal for years; for until within the last few months, ground had not been broken with the view to mining in the State. It will appear that such localities can only occur under the peculiar disposition of the strata just pointed out.

Little need be said of the character of the rocks of this region; they resemble all coal measures in being made of grits, sandstones, shales, &c. Some of these are of great thickness, and often entirely barren; such strata may be seen on the banks of the Hurricane, towards the river, where they rise to a height of 100 feet; and on Daniel's creek, where they are still thicker. At the latter locality, the stream has cut through the rocks along the strike, and exposed a fine section 150 feet high. The capping beds of the section are thick and arenaceous, and are eroded in a curious manner, the face of the rock being scooped out as if artificially. A section very similar to this, occurs on North River, which is noted as a locality of sulphate of magnesia. In my first examination of this region, I pointed out three workable beds of coal, superimposed upon each other. I have now reason to know that the number is greater, and think it not improbable, that in future, it may be doubled.

It is remarkable, that no attempts have yet been made to prove this coal field by boring, notwithstanding that the coal measures extend below the head of navigation on the Warrior, and present all the evidences of being productive. Even in the very middle of the field, no land is valued on which the coal is not distinctly visible. The beds are very generally composed of seams of coal, alternating with bands of shale; and this structure prevails throughout. The coal in the southern portion of the field is divided by joints into numerous rhomboidal blocks, that are held together by slight cohesion, and therefore crumbles very much by repeated handling. The

seams are often covered by thin laminæ of charcoal, in which vegetable structure may be distinctly traced. Carbonaceous smut is not uncommon on the top of the coal, in thin layers.

The following sections, from actual measurements, will give a correct view of the coal beds between Hurricane and Davis's creek:

Coal	15	inches.
Shale	5	"
Coal	9	"
Shale	1½	"
Coal	7	"
Shale	1	"
Coal	9	"

This bed is on a branch of Daniel's creek, and is the property of the Messrs. Eddins. The course of the principal vertical joints in the coal is N. E. and S. W., and the dip N. of W. about 1 in 15. The 5-inch shale is hard, and carbonaceous, and breaks with a clean fracture. The crop coincides with the strike, and being on the dip, is favorably situated for draining, and bringing out the coal. The bed has been worked in four "drifts" or "headings" from the crop. The disadvantage attending this method consists in the fact, that, it keeps the works in bad ground so long, where the roof is not sound.

This is the second instance of mining enterprise in the State, and considering the difficulties attending the commencement of a new business, with unskilful hands, it is quite encouraging. The coal is drawn up from the pit on an inclined plane, by horse power, carried to the river, and conveyed down another plane to the boats.

There are other beds in this vicinity, that were not opened so as to admit of examination.

The following is from a pit opened by Mr. Randolph, at no great distance from the preceding. The dip is E. N. E.:

Coal	4	inches.
Shale	2	"
Coal	7	"

Shale	4	inches.
Coal	8	"
Shale	8	"
Coal	8	"
Shale	2	"
Coal	12	"

This bed was barely exposed when I saw it.

The next section is from an open excavation on a bed worked by Mr. Hewell. The dip is N. E.:

Coal	10	inches.
Shale	11	"
Coal	14	"
Shale	3	"
Coal	16	"

This excavation was carried to the limit that this mode of working will admit, for it is obvious that when six feet of shale is removed, together with some surface earth and loam, that the expense becomes too great to leave any reasonable profit.

Towards the summit of the ridge, Mr. Pitcher has opened a bed, and as I found the raising of the coal in progress, it afforded me an opportunity of easy examination. The dip is very slight, and towards the E. N. E.:

Coal	8	inches.
Shale	10	"
Coal	8	"
Mottled clay	42	"
Coal	19	"
Shale	2	"
Coal	8	"
Shale (carbonaceous)	3	"
Coal	12	"

The upper coal, separated from the lower by 42 inches of clay, is quite soft and partly decomposed; it may, however, become harder under ground. The 3-feet shale is black, and

mixed with thin laminæ of coal, and filled with stigmaria. The mottled clay is of a gray and white color, and contains nodules of iron stone. This is not the only locality of carbonate of iron in this region, I saw very promising specimens of this valuable ore, of both concretionary and stratified varieties; but where no pits are open, nor explorations under ground in operation, it is impossible to say any thing of their economic value.

As these sections give a correct view of the character of the productive measures of this region, it is unnecessary to describe in detail, the others that I examined. The millstone grit east of this, sinks so gradually, as to be scarcely perceptible, as a ridge, nor does it become prominent till we reach Bucksville; and the productive coal measures seldom approach nearer than a mile or two.

On the sources of Davis's creek, coal is found, which is the nearest to the iron region that I have seen; the dip is N. W.

Farther north, and between the junction of the two great branches of the Warrior and Five mile creek, the seams become thicker, but the interposed bands of shale continue.

A few sections on, or near the Locust Fork, will give a clear view of the character of the seams in this part of the field.

On Coal creek, which flows into the river from the north west, about four or five miles above the junction of the Locust and Mulberry Forks, a bed of coal is laid bare for a distance of one hundred yards. It shows the usual alternations of coal and shale.

Section on Coal Creek.

Coal,	13 inches.
Shale,	1 "
Coal,	5 "
Shale,	1 "
Coal,	22 "

Between this point and Williams's ferry, another bed is seen outcropping on the same side, and under the river bluff. The thick overlying sandstones rise up into a bold cliff, 150 or 200 feet in height, and the coal alluded to is exposed by the encroachment of the river. When I examined it, it was barely

above the edge of the water; it sinks gradually, down stream, and is soon only found in the bottom of the river, where the thick seam has been worked by the owner. The dip is S. W., and as it is inclined obliquely from the river, only comparatively a small part can be explored above the level of the water.

The following is a section of this bed:

Coal	5	inches.
Shale	½	"
Coal	13	"
Shale	6	"
Coal	5	"
Shale	4	"
Coal	18	"

About one mile and a half from this, and on the hill descending towards the ferry, I examined a bed which gave these results:

Coal	15	inches.
Shale	5½	"
Coal	22	"
Shale	1	"
Coal	3	"

A very remarkable bed was examined about two miles below the mouth of Village creek. A small rivulet that empties into the creek, from the east, has washed a point of land adjoining the river low ground, and exposed this section:

Coal	15	inches.
Shale	3	"
Coal	5½	"
Shale	5	"
Coal and Shale	6	"
Coal	15	"
Shale	1	"
Coal	4	"
Shale	12	"
Coal	26	"

No coal has been taken from this bed; the exposed outcrop of the coal is soft, and in part, disintegrated, so that doubts have been entertained of its quality; but these will disappear when the bed is fairly opened.

At the mouth of Village creek* a bed of coal was examined, of which, but little was known beyond one or two of the thicker seams, which were worked; the existence of the rest being scarcely noticed. This may seem strange, but it occurs in this way: nearly all the coal that is raised here is taken from the bed of the river, or other streams. When a bed is discovered, it is generally one of the thick seams, that has escaped the denuding action of the water; the others after having been cut through and removed in the bed of the stream, remain hidden in the banks by the mud and the debris of the overlying slates. Even when the overlying loose beds are removed by the shovel, and the coal is reached if the seam be thick enough to work, no farther search is made below this, unless some accident, or some natural exposure has directed attention to the underlying portion of the bed. It is for this reason, that the coal on the river has passed for 30-inch coal, that being the thickness of the seam worked. I did not meet with two persons, during my examination of this region, who were acquainted with the character or thickness of the beds at which they were at work.

I witnessed here, the novel process in the art of mining, namely, diving for coal. A flat boat is moored parallel with the joints, and near the edge of the coal; long wedge shaped crow-bars are driven into the seams by means of mauls manœuvered by the men in the boat. When a ledge of about two feet is loosened, in this way, across the seam, the men take the water, and dive two or three together, according to the size of the masses to be brought up, and lift the coal bodily to the surface, and place it in the boat. As an improvement on this simple process, a crane is rigged on the boat, and a chain slipped round the blocks of coal, raises them into the boat. I have

* The measurement of the beds on this part of the river, and other definite information, is mainly due to the assistance of Mr. D. Hanby and Mr. Allen Wilson.

seen, in this manner, masses raised, that weighed 800 or 1,000 lbs. The coal thus raised, is free from all shale and other impurities, for, as the coal parts along the bands of shale, the latter are left behind. Notwithstanding the primitive appearance of this method of raising coal, it is, nevertheless, under favorable circumstances, and where the water is not too deep, one of the cheapest modes in practice, and with the addition of a diving dress, I am inclined to think that in no other way could coal be raised at an expense so moderate.

SECTION OF THE BED ON VILLAGE CREEK.

Coal	5	inches.
Hard under-clay with stigmaria	4	"
Coal	15	"
Under-clay with stigmaria	10	"
Black shale " "	4	"
Coal	18	"
Shale	1	"
Coal	8	"
Grey under-clay	17	"
Coal	38	"

The whole rests upon a soft whitish under-clay. Stigmaria are more abundant here than I have found them any where else. This bed, with all those on the Warrior, is very slightly inclined, and hence the numerous natural exposures. It is laid bare in the bed of the creek, in more than one place.

About half a mile above Williams's ferry, a bed of coal is found in the river, and a shaft has been sunk through the sandstones on the bank until the coal has been reached, which presents the following section:

Coal	18	inches.
Shale	4	"
Coal	3½	"
Shale	2½	"
Coal	20	"

This bed outcrops on the back of the hill, and on a stream a few hundred yards lower down the river. At the latter place, another seam of coal is found, 20 inches thick, and separated from the section above by a stratum of sandstone 15 feet in thickness. This is the only instance of any thing like regular mining in this whole region, and the first attempt at reaching the coal by means of a shaft. Mr. Hanby is the proprietor, and is prosecuting the work with as much energy as the force he can command will allow, where he has to begin with inexperienced hands.

Another section of a bed is found in the river, near the mouth of Five Mile creek.

Coal	8	inches.
Shale	1	"
Coal	48	"

It is probable that the lower thick seam has, as usual, bands of slate running through it; but as it was measured below water, they could not be detected.

COAL OF THE MULBERRY FORK, IN WALKER.

A very remarkable change takes place in the character of the coal on this branch of the Warrior; it becomes very much cleaner and harder; although it breaks up into small pieces, it rarely produces much slack; and as it comes from the bed, it resembles screened coal. The horizontal partings of the seams often exhibit casts of plants that give a dull lustre to the coal, which makes it appear almost slaty. This, of all the coal in the State, will best bear transportation, on account of its superior hardness.

The first coal that I saw here occurs on a branch of Dorsey's creek, which has supplied some smithies in the neighborhood. It is favorably situated, lying quite high, on the side of a deep ravine. The coal is of good quality.

Coal	4	inches.
Shale	5	"
Coal	30	"

It rests upon a bed of soft under clay. Not far from this, a thick bed of shale was examined, which contained nodules of clay iron-stone, in sufficient quantity to give it some interest.

I examined but a few of the many beds exposed in Walker. Near Gibbon's ford, there is coal found both in the river and on the land adjoining. The following is a section of one dipping N. W., strike N. E. and S. W.

Coal, - - -	7	inches.
Shale, - - - -	2	"
Coal, - - -	26	"

On a small stream, named on the map of the State, Coal creek, but called in the vicinity, Cane creek, I saw a very excellent bed. It dips S. W. 6°, but a little lower, the rocks dip about 10°.

Coal, - - -	31	inches.
Shale, - - -	7	"
Coal, - - -	7	"

On the stream next below Coal creek, there are some beds of great value; one of these, found towards its head, (the property of Mr. John Burdin,) is finely situated upon high ground, about half a mile from the river. It presents this section:

Coal, - - -	34	inches.
Shale, - - - -	$5\frac{1}{2}$	"
Coal, - - -	31	"

The shales of this part of the field are laminated, as I have mentioned in the preceding pages.

There are seams in the river that appear to be four feet in thickness. I saw here indications of the Cannel coal, which I afterwards found on Lost creek.

Near Bee shoal, coal is raised from the bed of the river. I saw here coal 30 inches thick, but was unable to determine the existence of other seams, which it is highly probable are to be found. Strike N. N. W. and S. S. E., dip W. S. W.

On Burnt Cane creek I measured a bed, with the following result:

Coal, - - - -	38 inches.
Shale, - - - - -	$2\frac{1}{2}$ "
Coal, - - - -	2 "
Shale, - - - - -	8 "
Coal, - - - -	10 "
Shale, - - - - -	$1\frac{1}{2}$ "
Coal, - - - -	8 "

Below the mouth of Lost creek, coal is found outcropping upon a hill side, 60 or 80 feet above the level of the river, an exceedingly convenient mining ground. The coal is completely drained, so that it is quite rusty on the surface, where it is exposed. The following is a section:

Coal, - - - -	8 inches.
Shale, - - - - -	$1\frac{1}{2}$ "
Coal, - - - -	14 "
Clay, - - - - -	1 "
Coal, - - - -	15 "

There are also indications of another bed beneath this.

A wide sheet of coal is seen in the bottom of the river, not far from the last locality; it is about a yard thick, and is seen again a little lower down, about 60 yards from the river.

Near the mouth of Fanny's branch, a bed has been laid bare, and worked to a limited extent.

Section on Fanny's Branch.

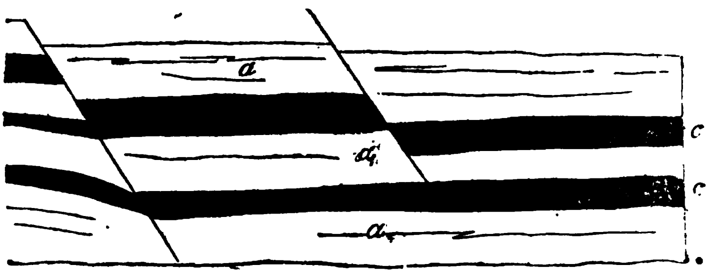
Coal, - - - -	16 inches.
Shale, - - - - -	4 "
Coal, - - - -	15 "
Shale, - - - - -	12 "
Coal, - - - -	6 "

This bed is exposed in Lost creek, where coal has been

raised from it. It appears again between the creek and the last locality. It is remarkable, as presenting the only uplift, or dislocation of the coal, that I have seen in the State. The uplift is one foot. The seams of coal present this appearance:

Fault on Fanny's Branch.

FIG. 12.



a, a, a—Shale. *c, c*—Seams of Coal.

On Lost creek, some fine exposures occur near the point where the Jasper road crosses it. They are only seen, however, in the bed of the creek. A section of the principal bed is as follows:

Coal,	- - -	10 inches.
Slate,	- - - -	14 "
Coal,	- - -	48 "

There are at least four other beds superimposed on this, which appear higher up stream. One of these is remarkable for having a thin seam of Cannel coal on the top of the common coal. The depth of the water prevented my making a thorough examination of this valuable bed; yet it is interesting to know that Cannel coal exists in the State, and I have no doubt that future explorations will bring thicker seams to our knowledge.

These sections will give a fairer view of the Warrior coal field than a whole chapter of description; they are, however, limited to a very small portion of the entire area, but it is a part that must always attract attention, on account of its vicinity to the river, and it is for this reason that it has occupied so much of my time, at the risk of appearing to neglect other districts of the State. Notwithstanding the definite character and value of the information presented here, no one feels, more sensibly than I do, how very inadequately it represents this magnificent formation. R. C. Taylor, Esq., the geologist who first investigated the Appalachian coal-field of Pennsylvania, mentions that he was often obliged to climb to the tops of the trees to obtain a knowledge of the physical features of the country. I was not reduced to this necessity, but most of the facts relating to the sections of the coal beds, were obtained hammer in hand, wading about in the creeks and streams; frequently, it is true, assisted by persons whose interest in my investigations led them beyond the bounds of their own property.

The following list of fossils from the Warrior coal measures, was made out by Mr. Bunbury for Sir Charles Lyell:

"1. *Sphenopteris latifolia.* Ad. Brongn. 2. *S. Dubuissoni?* Ad. Brongn. 3. *Sphenopteris*, allied to the last, perhaps a variety of the same. 4. *Neuropteris tenuifolia*, Ad. Brongn. 5. *Neuropteris Grangeri*, or *N. gigantea?* 6. *Calamites cannaformis.* 7. *Calamite*, obscure specimen allied to the foregoing. 8. *Lepidodendron elegans.* var? 9. *Lepidodendron*, allied to *L. dilatatum.* Foss., Flora. 10. *Lepidophyllum?* 11. *Sigillaria* decorticated. 12. *Stigmaria ficoides.* 13. *Poacites?* 14. *Bechera tennis*, n. sp., very nearly allied to *B. grandis.* Foss., Flora. 15. *Asterophyllites? flaccida.* 16. *Phyllites*, resembling the leaf of *Sparganium.*"

"The palæontologist will perceive at once, that no less than half of the species in the above list agree with well-known European fossils of the old carboniferous formation, and the rest belong to genera which are common in our coal measures, and may perhaps agree with European fossils, when procured in a better state of preservation."

CHAPTER V.

Economic Relations of the Carboniferous System.

Coal—Comparison of the Warrior and Cahawba coal fields—Carbonate of Iron—Millstones—Fire-proof materials—Flagging stones—Marble.

Coal.—The earliest notice of the use of Alabama coal that I have been able to find, is contained in Silliman's Journal, Vol. XXVI, 1834, in a note by Dr. Alexander Jones, of Mobile, which, notwithstanding unavoidable mistakes, I have thought of sufficient interest to insert here.

Bituminous Coal.—"This State is very rich in bituminous coal, of a most excellent quality. It is in every respect equal, if not superior to the best English coal. I am using some of it in my little laboratory. It is very heavy, and burns with a good flame, and gives out much heat. It also yields the carburetted hydrogen gas in immense quantity. The vein, or formation of this coal, is very extensive. It is first seen in the bed of the Black Warrior river, near Tuscaloosa, and next appears on the surface of the ground, to the north-east, and east of that town, and pursues that course till it crosses the Alabama and Coosa rivers at their falls, or just above them. It passes, probably, for some distance into Georgia, and not improbably, in its south-western or western direction, into Mississippi.

Its principal width is found in Shelby and Bibb counties, where it is forty miles wide; it occupies the whole ground under the surface, and is covered by superficial patches of hard or soft slate stone, or shale, other minerals being rarely found near it. Blacksmiths in its neighborhood, dig it up, and work it in their furnaces. It is also used in an iron foundry in Shelby county. The land is smartly broken. The growth consists principally of chestnut, oak and pine, and being more or less poor, it has never, much of it, passed yet out of the hands of the general government, and can therefore be bought by any one, who wishes to own it, at $1 25 cents an acre.

In the winter season, this coal is brought down the river to Mobile from Tuscaloosa, in flat-bottomed boats, and sold at the same price as the Liverpool coal, or at from $1 to $1 50 per barrel. The strata of this rich and extensive coal bed, have an inclination of a few degrees, to the S. S. E.

I presume you will, ere long, receive a correct geological account of this extensive and interesting coal formation, from some gentleman of the Alabama University at Tuscaloosa, which is a very favorable point for observing it.

The facts which I have communicated, were obtained from an eminent lawyer of this place, who had visited that region, and from a laboring man, who had worked the coal in a blacksmith's shop, which he owned in that region. He informed me, that having worked at the coal mines in Virginia, near Richmond, he considered this coal deposit the richest, and as containing the best coal he had ever seen."

For domestic purposes, the Alabama coal has been sufficiently long in use, in the State, to have its quality in this relation settled. In Tuscaloosa, it is used in the houses, to the almost entire exclusion of wood. The price varies from ten to twelve cents per bushel. It is also used in Mobile for similar purposes, but to what extent, I do not know.*

During the months of August, September, and October, (1849,) there were about 200 persons engaged in the coal trade of the State; and as only three beds are worked under ground, the rest of the coal raised, is taken from the bed of the river, and streams, where of course operations can only be continued during the low stages of the water: and in general, it is only

* Mr. Hanby's account of his attempts at the introduction of Alabama coal into the Mobile market, would furnish an amusing chapter, on the difficulty of directing any trade from its accustomed channels. The intelligent proprietors of the gas works in that city, however, were not slow to recognise its value as a material for the manufacture of gas; and it has now, where it is known, I believe, a fair reputation. Much of what has heretofore been carried to market, under the name of coal, included every thing that resembled it in color; but I know from observation, that those engaged in the business at present, take every reasonable precaution to reject all impurities.

the seasons of leisure that can be devoted to the business by farmers, who are the principal proprietors.

It has already been stated, that the obstruction of the Warrior, which terminates the navigation of that river, is occasioned by the coal measures. Above this point, the river is only navigable during freshets, at which times alone coal is carried to Mobile. The boats used, are common flatboats, with gunwales made of solid timbers; the first class have a capacity of about 2000 bushels, draw 20 to 30 inches of water, and cost $70, or thereabouts. Coal is brought down the river to Tuscaloosa at about four cents a bushel, a distance of 50 miles, and thence to Mobile, a distance of 355 miles, at an additional cost of nearly four cents; the boat being a dead loss in either case, as it brings but a few dollars.

Coal is brought to Tuscaloosa in wagons from those beds exposed 5 or 6 miles east of the river, and 10 to 18 miles from the city. When the plank road, at present in contemplation, is constructed, it will greatly facilitate operations in that direction, more particularly, as it is intended to reach the iron region of Roup's valley.

It will be seen from the map, that the Warrior runs through the centre of the coal field, and its improvement 75 or 100 miles above Tuscaloosa, would leave little to be desired, in relation to the transportation of coal from this region; for it is supposed by those who have examined it, that with a very moderate outlay, the river below Tuscaloosa may be rendered navigable through the summer for light-draught stern-wheel steamers.

The attempts at improving this river, up to the present time, have been conducted on two different plans, the one in relation to its navigation at low water, and the other to high water navigation. The first and most expensive operations, consisted in the construction of jetties, &c., with the view of turning the water into a narrower channel. The plan appears to be good, but the execution was defective. The jetties were, in many cases, not connected with the banks, and not reaching above water, they became dangerous, submerged islands, to boats high coming down at high water.

Later improvements have been altogether conducted with the view to the removal of obstructions to high water naviga-

tion, and consequently, it became necessary to undo, in many cases, what had already been done, at considerable expense.

The work principally consisted in the removal, from the shoals, of prominent points of rock, widening channels, cutting away dead timber, &c. The execution of this was entrusted to sensible men, who knew from experience, the dangers and obstrctions of the river, and I can bear testimony to the faithful manner in which they have discharged their duties. The clearest proof of this is found in the fact, that formerly, it required 4 feet rise in the level reaches to produce 1 on the shoals; now, 3 feet is sufficient to give the same rise on the shoals. The nature of the obstructions in the river may be gathered from what has been said of the geology of this region. The coal measures are made up, as I have shown, of alternations of hard and soft beds; the latter are worn down, or washed away, whilst the former are left, and hence, the bed of the river consists of a succession of level reaches and shoals. In the level portions, beds of coal are generally found, and it would be no difficult task to cut a channel through the shoals, but, without great caution, this would let the water off too fast; and it is easy to see that the whole river might, by continuing the process, be converted into a rapid. In this consists the danger of river improvements, by the removal of shoals.

The alternations of shoals and deep water on the Warrior, fits it, in a peculiar manner, for what engineers call slack-water navigation, which is effected by the construction of dams across the river, that converts it into a canal. The dams are passed by either locks or sluices.

I have alluded to this subject because of the intimate connexion, of the improvement of this river, with the developement and interests of the coal field through which it flows.

A glance at the map of the United States and South America, will show the importance of the geographical position of our coal fields. It will be recollected that the Alabama coal fields come down to the head of navigation on the Warrior at Tuscaloosa; and within ten miles of that point on the Cahawba. It may be interesting here to take even a rapid view, of the most available deposits of coal, on the Atlantic slope, the Gulf of Mexico, and the region still farther south.

Virginia Coal Fields.—Towards the north, the Virginia coal region approaches the sea-board nearer than any other. The Clover Hill pits, situated in Chesterfield county, are connected with the navigation of James river at Port Walthall, by a rail road 22½ miles in length, which cost the company $100,000.

The price of the coal on tide water is $3 to $3.50 per ton, and cost of transportation $1 per ton. At these pits 6000 bushels a day are raised.

At Port Walthall it is shipped down the river for the northern and southern ports.

Maryland.—The next coal region, along the sea-board, is that of Maryland, at Cumberland. Coal from this region in 1847, paid for transportation to Baltimore $2.50 per ton, and to Washington, $3.56 per ton. In the former city the price in 1848 was $6.00 to 6.25 per ton. The transportation on the canal being only one half cent per ton per mile. The length of this canal is 187 miles.

These, and the Richmond coal mines are the most accessible sources of bituminous coal for the Atlantic States.

Tennessee.—Of the Tennessee coal fields, Dr. Troost states that "coal is shipped from various points, but particularly from Kingston; from whence it passes down the Tennessee river more than six hundred miles to the Ohio and thence, more than a thousand further, to New Orleans; making a voyage of no less than *seventeen hundred* miles of inland navigation. From the western margin of the Tennessee coal-fields, a certain quantity of coal is sent down the Cumberland river, nearly an equal distance, to its place of destination."*

Illinois and Kentucky.—The rest of the coal brought down the Mississippi, is, I believe, derived from the Illinois and Kentucky coal fields, of which Mr. Taylor gives us the following statistics; "There is no coal in the Ohio river nearer to its

* Statistics of coal; to which valuable work I am indebted for much of the information contained in this article.

junction with the Mississippi than Salem, near Shawneetown, 16 miles above the mouth of the first named river. On the Mississippi, it is rather a shorter distance, being sixty miles to Muddy creek, and thence twenty five miles up that creek to the first coal bed there, or twelve miles by land. Some coal operations commenced here some few years ago, having in view the supply of the towns along the Mississippi, as far even as New-Orleans. The present supplies of coal to the lower country are obtained from a vast distance up the Cumberland and Tennessee rivers, but especially from Wheeling, Pittsburg, and the intermediate points, 900 miles farther from the market than the Illinois coal of Muddy creek. The estimated expense of delivering this coal at New Orleans, by arks, is about $2.25 per ton—while the minimum price of coal there is 25 cents a bushel—$7.50 a ton. In winter time from 50 to 62½ cents per bushel, or $12 to 15 per ton, have been occasionally the retail price there. This Muddy creek coal seam is a horizontal bed 6 or 7 feet thick, above which is another vein, not hitherto worked.

Coal can be thrown from the mouth of the drift into a boat. Its quality is most excellent, igniting readily, and caking together perfectly, without making much clinker. It has been used for 50 years by the old French settlers, to make edge tools, which have borne a high reputation.

What is termed St. Louis coal, supplied to the steamers, burns with a good flame, and cements like that of Pittsburg; ashes dark gray, in small quantity, and consumes with little waste. It is often mixed with yellow sulphuret of iron in flakes, occurring on each face of the sectional fracture; and consequently is not, we understand, in so good repute for the purposes of iron manufacturing."

At Hawsville, on the left bank of the Ohio, 120 miles below Louisville, is a coal bed four feet thick. The upper 18 inches of this bed consist of Cannel coal; the remainder is common bituminous coal, two and a half feet.

The price of this coal at New Orleans,* was 62½ cents to $1

* The coal consumed in New Orleans is brought, principally, down the Mississippi; the price ranges between 75 cents and $1 75 per barrel; 13

per barrel, of two and a half bushels. It is in request there for the use of the towboat companies.

Hawsville is about 258 miles above the mouth of the Ohio. The coal seam is nearly horizontal—appearing on both sides the river, in a position remarkably favorable for loading into vessels lying in the Ohio. It is a compact, largely conchoidal, coal, producing a bright flame; does not cement or adhere together in burning, but on the contrary, falls into profuse white ashes. Although 700 miles in advance of Pittsburg, it has been hitherto, we are told, unable to compete with that coal, which is floated down the Ohio in arks, and, it is said, can be mined cheaper."

"The Hawsville Cannel is especially liked for steam engines. For domestic use, we think it is objectionable, on account of the great quantity of very white ashes which are left after combustion, filling up the grates," &c.

Cuba Coal.—In Cuba, a seam of Asphalte, or Chapapote, as it is called, is found about three leagues from Havana. There are other seams of this highly bituminous substance, in other parts of the island, and although it is said to be an excellent "combustible, when much flame is a desideratum, for such purposes as evaporation, and for heating surfaces; and in this respect it must be superior to many descriptions of fuel whose proportion of volatile matter is less;" yet, I cannot learn that it is gaining ground as a fuel, for even the generation of steam; and it is quite certain that the depot of coal, for the Royal Mail Company's steamers, is supplied by coal imported from the British dominions, as will appear from the following extract:*

of which barrels are estimated equal to a ton. The following table (from the Statistics of Coal) exhibits the increase of consumption of coal in that city for a series of years:

Ys. Bbls.	Ys. Bbls.	Ys. Bbls.	Ys. Bbls.	Ys. Bbls.
1830—40,800	1836—85,328	1841—121,233	1844—227,788	1846—262,800
1832—50,000	1838—99,220	1842—140,582	1845—281,600	1847—356,500
1834—60,000	1840—99,919	1843—255,568		

* Statistics of Coal.

"The trade in coals from Great Britain to the West Indies is limited. They are partly required for furnaces, but the principal quantity consists of a particular description of coal for steam purposes, under contract with the British government, and is a trade of comparatively recent origin. The government stations are Jamaica, Antigua, and Barbadoes, and some coals go to St. Thomas's. The average price of coals there is about 45s. to 47s. ($10 90 to $11 40) according to the demand. They have been freighted from London, costing 20s. per ton there. The freight from Newcastle to the West Indies is 27s. 6d. to 30s."

"*English Bituminous Coal imported into the West Indies.*

Ys.	Tons.	Ys.	Tons.
1831,	48,536	1841,	71,311
1832,	43,980	1844,	77,338
1840,	82,564	1845,	102,339

British Coals imported into foreign West Indies.

1844,	26,592
1845,	22,154

In the West Indies, the price of coal varies from 45s. to 47s. per ton for government contracts; it has been occasionally much higher.

The importation of copper ore from Santiago, and other ports of Cuba, constitute a very considerable portion of the trade of Swansea. The ships employed in the trade, are from 300 to 500 tons burden. The chief back freight for these ships is Welsh coal. It was feared by the shippers of this Welsh coal, that the discovery of a supposed bituminous coal of high value, at more than one point within a few miles of a shipping port of the island of Cuba itself, would materially diminish, if not entirely cut off, the market for the supply of the free-burning coals of South Wales. Owing, however, to other circumstances, rather than to any deficiency in the quality of the Cuba asphaltum, there has not, at present, been experienced any change in the importation of foreign coals; but the

demand in a tropical climate can never, we think, for obvious reasons, be very extensive."

Beds of asphaltum are also found in Barbadoes.

Texas Coal Fields.—"Coal is now well known to exist abundantly in Texas, although the country has not been geologically examined. There is no doubt but coal prevails at intervals entirely across the country, in a north-east and south-west direction. Its general position is about two hundred miles from the coast.

"On Trinity river, two hundred miles from Galveston, the coal region there was investigated in 1846, and found to be more extensive than was anticipated. A company, under the title of the 'Trinity Coal Mining Company,' was incorporated by an act of the Texan Congress in 1840. Both anthracite and semi-bituminous coal, somewhat like the cannel, in appearance, occur here.

"Mineral coal, in great abundance, prevails not far from the Mustang Prairie. It is also found, accompanied with excellent iron ore, in the vicinity of Nacogdoches. According to report, this coal is abundant, rich, and of a fine appearance."

"A bed of coal extends across the Brazos river, towards the Little Brazos and the San Andres, down which stream it may without difficulty be transported at high water.

"Near the city of Austin, on the eastern border of the Colorado, is a peak, called Mount Bonnell, overlooking Austin, and having a fall of seven hundred feet perpendicular to the bed of the Colorado. This and other hills, although not scientifically examined, are known to contain beds of anthracite coal.

"On the Rio Grande, south-west of Bexar, is a great abundance of bituminous coal. The navigation of this river is reported to be free for eight months in the year."

This, I believe, includes all our information on the subject of the Texas coal-region.

Panama Coal.—The coal of this region appears to be brown coal, or lignite, and like that of Talcahuano, in Chili, is supposed to belong to the tertiary formation. This is the charac-

ter of the coal, so far as we know, of the whole of South America, nor have we any positive evidence of the existence of true coal on any part of this immense continent. Of the quality of the South American brown coal, we have the most contradictory accounts: by some it is said to be of good quality, whilst by others it is condemned as inferior.

I have thus, I suppose, fairly represented the sources of this fuel, that would be likely to come into market in competition with the Alabama coal, on the Gulf of Mexico, and still farther south and west; as well as the prominent conditions under which it is found, so far as they would be likely to affect its price, and supply in that market. I do this principally with the view of furnishing data to such of our citizens as may feel disposed to investigate the subject in a commercial point of view.

It now only remains for me, in conclusion, to show the comparative value of our coal, for the purposes to which it is likely to be applied.

Although I have not access to an official report, on the coal used in the gas works in the city of Mobile, I am informed that it is highly valued, for the manufacture of gas. But even in the absence of this practical knowledge, we have abundant evidence of the adaptation of our coal to this purpose, as well as to other ordinary uses, in the following analyses, for which we are indebted to Sir Charles Lyell:

*Analyses of Bituminous Coal.**

		Carbon.	Vol'le matter.	Ashes.
VIRGINIA	Clover Hill	76.49	13.64	9.87
	Black Heath	80.38	10.27	9.35
	Deep Run	82.90	10.74	6.36
	Powell's	86.54	8.76	4.70
Alabama		80.96	12.96	6.08

The Virginia coals, which are the most bituminous in the United States, furnish the principal part of the coal used in

* Mr. P. Henry, Quar. Jour. Geol. Soc., No. 11, p. 270.

the gas works of New York, Philadelphia and Charleston. And until recently, the Black Heath mines furnished the chief supply for the former cities.

The value of coal for the production of gas, other things being equal, will depend upon the amount of hydrogen they contain. In the five preceding specimens, the hydrogen stands thus:

Clover Hill	5.23
Black Heath	4.08
Deep Run	4.77
Powell's	4.23
Alabama	5.13

And the value of coal, as ordinary fuel, is derived from the carbon and hydrogen. Now, these analyses, in this relation, settle the position of the Alabama coal.

In connection with the value of bituminous coal, when applied to steam navigation, Mr. Trimble gives some experiments made by steamboats on the Ohio. The result is as follows:*

"Four and fifty steamboats, using twenty cords in the twenty-four hours, and running two hundred days per annum, will consume an amount of wood, whose value, at $2 50 per cord, would be	$4,500,000
By the use of coal, during the same, and producing similar effect	1,500,000
Annual saving	$3,000,000

The following considerations are urged in favor of coal.

1. It makes a more uniform and more easily regulated fire than wood.
2. The economy in the use of coal over wood is three-fifths.
3. The weight of equivalent quantities of coal and wood, is as one to three.
4. The bulk do. do. one to nine.
5. The labor and expense of putting on board, as one to four."

But the most valuable contribution to this branch of practical knowledge, was made by Walter R. Johnson, Esq., in an

* Statistics.

elaborate "report of experiments on the evaporative power, and other properties of coal;"* made under authority of the navy department of the United States. In these experiments, conducted with the greatest care, all the conditions in any way likely to affect their adaptation to the production of steam, and to steam navigation, were minutely examined. The experiments, too, were conducted upon such a scale of magnitude, as caused them to approach actual ordinary circumstances.

It is to be regretted, that among the specimens examined, there was not one from Alabama. The number of samples experimented upon were forty-nine; of these, nineteen were bituminous, twelve free burning or semi-bituminous, nine anthracite, one natural coke, two mixtures of anthracite and bituminous coals, and one of dry pine wood. The quantity of coal used in each experiment, was from 800 to 1200 pounds. A double-flue cylinder boiler, 30 feet long, and 3½ in diameter, was used, and the quantity of water 12,302 pounds.

The coals were all analysed, and the results tabulated. The great practical value of these tables precludes the necessity of any apology for introducing them here.

* Ex. Doc., vol. 6, 1843-4, 600 pages.

General synoptical Table of the character of the several Coals.

DESIGNATION OF COALS.	Specific gravity.	Weight per cubic foot, calculated from specific gravity.	Weight per cubic foot, by experiment.	Ratio of actual to calculated weight.	Cubic feet of space required to stow a ton.	Vola.ile combustible matter, in 100 parts.	Fixed carbon, in 100 parts.	Earthy matter in 100 parts.
Beaver Meadow, slope No 3 Pa	1.610	100.645	54.93	0.546	40.78	2.38	88.94	7.11
Beaver Meadow, slope No 5 Pa	1.551	96.93	56.19	0.580	39.86	2.66	91.47	5.15
Forest Improvement,.........Pa	1.477	92.31	53.66	0.581	41.75	3.07	90.75	4.41
Peach Mountain,.............Pa	1.464	91.51	53.79	0.588	41.64	2.96	89.02	6.13
Lehigh ....Pa	1.590	99.39	55.32	0.557	40.50	5.28	89.15	5.56
Lackawana,...................Pa	1.421	88.34	48.89	0.550	45.82	3.91	87.74	6.35
Lyken's Valley,...............Pa	1.389	86.82	48.56	0.559	46.13	6.88	83.84	9.25
Beaver Meadow, navy yard Pa	......	......	55.08	......	40.65	......	......	8.10
Natural coke of Virginia,..Va	1.323	82.70	46.64	0.564	48.03	12.44	75.08	11.83
Coke of Midlothian coal,...Va	......	......	32.70	......	68.50	......	......	16.55
Coke of Neff's Cumb. coal, Md	......	......	31.57	......	70.95	......	......	13.34
Mixture 1-5 Midlothian and 4-5 Beaver Meadow,.........	......	......	54.29	......	41.26	......	......	8.88
Mixture, 1-5 Cumberland and 4-5 Beaver Meadow,.........	......	......	54.51	......	41.09	......	......	8.18
N. Y. & Maryland min. co Md	1.431	89.44	53.70	0.600	41.71	12.31	73.50	12.46
Neff's Cumberland,........Md	1.337	83.28	54.29	0.652	41.26	12.67	74.53	10.34
Easby's "coal in store,"... Md	1.307	81.69	53.47	0.655	41.90	14.98	76.26	8.08
Atkinson & Templeman's, Md	1.313	82.09	52.92	0.645	42.33	13.53	76.69	7.33
Easby & Smith's ....Md	1.332	83.26	51.16	0.614	43 78	14.52	74.29	9.30
Cumberland (navy yard)...Md	1.414	88.40	53.29	0.603	42.04	14.87	70.85	14.98
Dauphin and Susquehana, Pa	1.443	90.19	50.54	0.560	44.32	18.82	74.24	11.49
Blossburg,......................Pa	1.324	82.73	53.05	0.641	42.22	17.78	73.11	10.77
Lycoming creek,.............Pa	1.388	86.74	55.38	0.638	40.45	13.84	71.53	13.96
Quin's Run,...................Pa	1.331	83.22	50.34	0.605	44.50	17.97	72.79	8.41
Karthaus.......................Pa	1.284	80.22	52.54	0.655	42.63	19.53	73.77	7.00
Cambria county,.............Pa	1.407	87.94	53.46	0.608	41.90	20.52	69 37	9.15
Barr's Deep Run,............Va	1.382	86.41	53.17	0.615	42.13	19.78	67.96	10.47
Crouch & Snead's............Va	1.451	90.71	53.59	0.591	41.80	24.38	59.98	14.28
Midlothian (900 ft. shaft)...Va	1.437	87.50	50.52	0.577	44.34	27.28	61.08	10.47
Creek Company's coal,......Va	1.319	82.48	46.50	0 564	48.17	32.47	60.30	8.57
Clover Hill,....................Va	1.285	80.36	45.49	0.566	49.25	32.21	56.83	10.13
Chesterfield Mining Co.....Va	1.289	80.57	45.55	0.565	49.18	32.63	58.79	8.63
Midlothian (average).......Va	1.294	80.90	54.04	0.568	41.45	29.86	53.01	14.74
Tippacanoe,....................Va	1.346	84.14	45.10	0.536	49.67	34.54	54.62	9.37
Midlothian, ("new shaft,") Va	1.325	82.82	47.90	0.581	46 76	35.77	56.40	9.44
Midlothian, (screened,) ....Va	1.283	80.21	45.72	0.570	48.99	34.70	54.06	9.66
Midlothian, (navy yard)....Va	1.390	86.86	54.47	0.627	41.13	29.12	56.11	14.14
Pictou, (from NewYork, N S	1.318	82.35	53.55	0.650	41.83	27.83	56.98	13.39
Sidney,........................N S	1.338	83.66	47.44	0.567	47.22	23.81	67.57	5.49
Pictou, (Cunard's) ....N S	1.325	82 83	49.25	0.595	45.48	25.97	60.74	12.51
Liverpool,......................Eng	1.262	78.89	47.88	0.607	46.78	39.96	54.90	4.62
Newcastle,....................Eng.	1.257	78.54	50.82	0.647	44.08	35.83	57.00	5.40
Scotch,......................Scotland	1.519	94.95	51.09	0.538	43.84	39.19	48.81	9.34
Pittsburg.......................Pa	1.252	78.37	46.81	0.598	47.85	36.76	54.93	7.07
Cannellton, ...Ind.	1.273	79.51	47.65	0.599	47.01	33.99	58.44	4.97
Dry Pine wood, ...	......	......	21.01	......	106.62	......	......	0.307

Besides the analyses, we have other highly interesting properties indicated: such as the difference between the weight, calculated from the specific gravity, and that derived from actual measurement, the space required to stow a ton of coal, &c. From these analyses, it would appear that pretty accurate conclusions may be drawn in relation to their evaporative power, as will appear from the following extract:

Heating powers derived from ultimate analyses of Coals.—"The comparisons which I have been enabled to make between the practical steam-generating power of the *combustible matter* of several kinds of coal, and that derived from their ultimate analysis, and thence calculated from the quantity of carbon which they severally contain, enable me to offer at present, the following cases illustrative of this subject. Should I be hereafter empowered to complete the series of researches so as to obtain ultimate analyses of all the coals which have been tested by evaporation, a mass of evidence would be accumulated, which might, in all probability, set the question finally at rest.

	Evaporative power of 1 of combustible matter by steaming apparatus.	Power calculated from *carbon* ascertained by ultimate analysis
Cambria county, Pennsylvania,	11.550	11.522
Midlothian, (new shaft,) Virginia,	11.460	11.731
Newcastle, England,	10.898	10.545
Clover Hill, Virginia,	10.537	10.445
Scotch,	10.206	10.393
Indiana, (Cannelton,)	9.557	9.509
Mean,	10.701	10.691

"Notwithstanding this very remarkable approximation (or, I may say identity) of the two numbers in these six instances, I would not be understood as announcing the universality of the law that the weight of carbon alone in coal is the only available element of its heating power. I only bring forward this number of facts, all tending in the same direction, all in harmony with each other and with pre-existing experience, so far as a

tolerable degree of exactness has been given to researches in relation to this subject."

It appears from the analyses of Alabama coal, given on page 103, that it stands high in relation to the amount of carbon it contains; and if Mr. Johnson's inference be correct, it will rank well in evaporative.

There is, however, too wide a difference between the analyses of Virginia and Alabama coals, made for Sir Charles Lyell, and those of Mr. Johnson, to render any comparisons that may be made, satisfactory.

After the experiments, the coals are arranged in classes, "in reference to different characters, considered to be of the most practical importance, and based, in every instance, on the numerical results of experiments. These classes or ranks are as follows:

1. Relative weight.
2. Rapidity of ignition.
3. Completeness of combustion.
4. Evaporative power under equal weights.
5. Evaporative power under equal bulks.
6. Evaporative power of combustible matter.
7. Freedom from waste in burning.
8. Freedom from tendency to form clinker.
9. Maximum evaporative power under given bulks.
10. Maximum rapidity of evaporation.

The following concise synoptical table of these ranks, applied to twenty samples of coal, is taken from a review of the report in Silliman's Journal, and will give a practical view of the comparative value of these coals for steam navigation:

CLASS OF COALS.	NAMES OF SAMPLES.	Evaporative power of *equal weights* of coal.	Evaporative power of equal bulks of coal.	Freedom from tendency to clinker.	Rapidity of action in evaporating water.	Facility of ignition, or readiness with which steam is *got up*.	Sum of the relative values in the preceding columns.
Cumberland, Md.	Atkinson & Templeman's,	1000	1000	282	828	505	3615
free burning, bituminous.	Easby's coal in store, -	936	946	451	658	286	3277
	Easby & Smith's, -	931	903	197	886	329	3246
	N. Y. and Md. Min. Co.'s,	914	927	111	677	376	3005
	Neff's, - - -	882	906	133	877	298	3096
	Averages, -	932	936	235	785	359	3248
Anthracites of Pennsylvania.	Beaver Meadow, slope 5,	923	982	1000	722	207	3834
	Forest Impr't, (Schuylkill,)	940	955	741	790	150	3576
	Peach Mountain, (do.,)	945	964	198	901	142	3150
	Lackawana, - -	915	844	484	779	187	3209
	Lehigh, - - -	835	872	555	792	153	3207
	Averages, -	911	923	595	797	168	3395
Free burning bituminous coals of Pennsylvania.	Quin's Run, - -	960	913	458	726	667	3724
	Blossburg, - - -	908	911	176	996	595	3586
	Dauphin and Susquehanna,	873	835	171	766	602	3287
	Cambria County, - -	863	860	172	867	250	3012
	Lycoming Creek, -	833	871	184	706	291	2885
	Averages, -	887	878	232	892	481	3299
Highly bituminous coals of Virginia.	Chesterfield Mining Comp.	841	726	143	1000	427	3137
	Midlothian, screened, -	836	722	180	730	383	2856
	Creek Company's, -	787	692	136	981	299	2885
	Crouch & Snead's, -	779	786	112	635	431	2743
	Tippecanoe, - -	724	618	149	875	376	2742
	Averages, -	793	709	144	844	384	2872
Foreign bituminous coals.	Newcastle, Eng., -	809	776	191	827	595	3198
	Pictou, (Cunard's sam.) N S	792	738	97	928	588	3143
	Sidney, N. S., - -	747	669	276	764	424	2880
	Liverpool, Eng., -	733	663	323	857	581	3167
	Scotch, - - -	649	625	107	847	521	2749
	Averages, -	746	694	197	844	526	3027
Gen'l scale of relative values formed from the averages of each class.	Maryland free burn'g coals	1000	1000	395	880	682	
	Pennsylvania anthracites,	977	986	1000	893	319	
	Penn. free burn. bituminous	951	938	390	1000	914	
	Virginia bituminous, -	850	757	242	948	730	
	Foreign bituminous, -	801	741	331	948	1000	

From the foregoing scale it appears that in evaporative power under *equal weights*, the Cumberland class surpasses the anthracites by about 2.3 per cent., and under *equal bulks*, by 1.4 per cent. They also surpass the foreign bituminous coals 20 per cent. when we compare equal weights, and 26 per cent. by equal bulks. In freedom from clinker, the anthracites stand pre-eminent; in rapid production of steam, when once in action, the Pennsylvania bituminous coals are somewhat superior to all others, and for *getting up* steam, the foreign bituminous coals take less time than either of the other classes.

In conclusion, I present some views, showing the relative cost of steam and water power, taken from a lecture delivered in Hartford, 1844, by Gen. C. T. James:

"In regard to the cost of steam, as a motive power, compared with the expense of water, it needs no labored argument to prove that steam is at least as cheap, if not cheaper, than the other.

"To state the case as simply and intelligibly as possible, we will suppose water power in Hartford for sale at $4 per spindle, or its equivalent, the same sum which is charged in Lowell. A mill of 20,000 spindles would require an outlay for water power of $80,000. To place this statement beyond dispute, we will take one-half of this sum, say $40,000, (although I consider water power at Lowell, taking all local advantages into the account, as cheap as at any place with which I am acquainted.) The additional cost of a building suitable to contain 20,000 spindles, with all necessary apparatus for manufacturing purposes, erected on the bank of a river, together with raceways, flumes, wheel-pits, &c., would amount to $20,000, making an outlay of $60,000. The interest of this is, of course, $3,600. Add to this the expense of heating the water mill, which would be at least $2,000, and we have the sum of $5,600, with which to purchase fuel for a steam mill of corresponding size.

"Take, as a practical guide, the cost of fuel which is required to generate steam sufficient to supply the motive power for Bartlet, No. 1 and 2, Mills of Newburyport—for the James Steam Mills, of the same place; and we are warranted in saying that three tons of anthracite coal is all, and probably more

than would be required, per day, to generate steam sufficient to operate a mill of 20,000 spindles.

"Allowing the mill to be in operation 310 days in the year, there would be consumed 930 tons of coal, which can be purchased and delivered alongside the mill, at $4 42 per ton; making the sum of $4,110 60; add to this the pay of engineer and fireman, say $3 per day, which amounts to $930, and we have $5,040 60 as the entire cost of operating the steam mill; while the interest on the outlay for water power, together with the expense of heating, is $5,600; showing a balance in favor of steam of $559 40; and this, too, supposing the water mill and steam mill to be side by side, and the cost of water power reduced one half in price. A cotton mill of this description would manufacture about 700,000 yards of fine cloth per week, the cost of which, for motive power, would be a little over one mill per yard. I have made no mention, in this comparison, of the cost of engine, or water-wheels. I have set the cost of one against that of the other. The cost of water-wheels and shafting, sufficient to set a cotton factory in operation, will be as much, if not more, than that of a steam engine and shafting suitable for that kind of operation. There are advantages, however, in favor of steam for cotton manufacturing, to which I have barely alluded. Steam is indispensably necessary in manufacturing the finer and better qualities of cloth. When it is understood that the motive power, whether it be steam or water, costs less three mills per yard, it will be readily perceived, that, if from the use of steam there is a decided improvement in the character and appearance of the article manufactured over that produced by water power, you reap an advantage sometimes quadruple the entire cost of your power; or in other words, cotton cloths of No. 40 yarn, manufactured by steam, are now selling at from one to two cents a yard more in proportion to the cost than those of a similar number, manufactured from equal, if not superior cotton, in the absence of steam, by water power. It is true, that mills driven by water power, may, and many of them do, profit by the use of steam, both for the purpose of warming the mills and of maintaining a humid atmosphere. But such an arrangement, to be able successfully to compete with a mill driven by steam, must be kept up through the year; which adds the cost of steam to

that of water power; and of course an arrangement of the sort could not long compete with a mill driven by steam power alone."

Comparison of the Warrior and Cahawba Coal Fields.

We know too little, yet, of either of these fields, to make a fair comparison of their value, in any point of view—their relation to each, in truth, is not fairly established. Separated as they are, through their entire extent, by the interval of a few miles, which is occupied by a long valley, in which the older fossiliferous rocks come to the surface, and indicate the manner in which the carboniferous rocks were pushed up, and made to dip in opposite directions, I have been led to the conclusion, that they were once continuous, forming one unbroken coal field. Yet connected with this supposition, there are many questions yet unsolved. Why do we not find on the Warrior thick beds corresponding with those of the Cahawba? Do such beds exist on the Warrior, but have not yet been discovered? Or—seeing that the slight inclination of the measures on the Warrior is favorable to the removal of entire strata by denudation—have these thick beds been carried away, whilst the more highly inclined strata on the Cahawba, presenting their edges to the denuding forces, have remained? If they were once one field, whence the great difference in the structure of the coal, on the two rivers? Were the beds of the original coal field thicker towards the east, and did they gradually become thinner towards the west?. For the solution of these, and numerous other questions, the materials are not yet collected; they serve to show, however, how very limited is our knowledge of this interesting region. Although the Warrior coal field has been longer known, it remains to this moment unexplored, in that part of it which will one day (should the exploration be successful) be the most valuable: I allude to the portion of the field below the head of navigation. The want of capital, or the indisposition to invest it, which exists among the numerous proprietors of the Warrior coal region, will operate as a hindrance to successful operations; and growing out of this is the evil of being obliged to dispose of the coal immediately on its arrival at Mobile. For some years to

come, a considerable quantity of coal will be procured in the beds of the streams, or where it is but slightly covered by loose superficial beds, and in either case, without the investment of much capital. The slight inclination of the beds, and the physical features of the country, will always tend to lessen the expense of mining operations on the Warrior. The crumbling quality of the coal, as I have shown, applies to the southern extremity of the field only; and it must be recollected, that even here, we know but little of the character of the coal beyond the crop.

Another circumstance, tending to place this coal in unfavorable comparison with foreign coal in the market, is, that it is never screened. I know of no other coal taken to market under such circumstances. It is said that screening would but tend to increase the evil already arising from its disposition to crumble. I do not know how far this objection is correct, but it is certain that, in some instances, coal has been screened after it has reached Tuscaloosa. At all events, it would be far better to screen the coal, and charge a higher price for the screened portion of it, whilst the rest may be sold at a lower rate. The Cahawba field possesses an important advantage in the thickness of the beds, as well as in the absence of the bands of shale, so constantly present in the Warrior coal beds. However, when beds exceed 5 to 6 feet, it is considered no advantage in point of economy, the greater thickness scarcely compensating for the increased labor and difficulty of extracting the coal. I have learned recently that the bed on Ugly is not quite as thick as I supposed, and now that the bed is fairly opened, it proves to be only 8 feet. This, of course, is all the more favorable.

From the great inclination of the beds, it is obvious, that but little coal can be taken from the crop, and that mining processes must be adopted from the commencement. Operations there, then, will always require some outlay at first, for the sinking of shafts, machinery for raising coal, and water. And in the circumstances which I have mentioned, consist the difference between the two coal fields. The Warrior coal beds are not so thick, and contain troublesome bands of shale, but they are favorably situated for mining, and in general, will require no expensive works. The beds on the Cahawba are thick

and free from shale, but their great dip will require the investment of capital from the commencement.

There is no doubt as to the excellent quality of the coal, although but little of it has been, as yet, taken to market. Although the area is small, compared with that of the Warrior coal field, yet the quantity of coal contained in it is immense, and every day is bringing beds to light that were not known when I first explored it. The bed near the saw-mill has been opened, and turns out to be a two-yard seam; this will of course lessen the land carriage, and when the outcrop is traced on the surface, it may yet be found in a more favorable position.

Carbonate of Iron.

This is the ore that furnishes nearly all the iron manufactured in England; although not so rich as the other ores, the ease with which it is reduced, and the good quality of the iron, compensates for its poverty.

In many of the coal beds of the Warrior, this ore is found in the overlying shale. But as so little mining has yet been done, it is impossible to say any thing, as yet, in relation to quantity.

Millstones.

The conglomerates of the millstone grit furnish excellent millstones. On Dry creek, above Elyton, on the head waters of Hurricane, and at numerous other localities, quarries have been opened, and millstones from them used in the State.

Fire-Stone.

There is no better material for this indispensable article, than the arenaceous beds of the millstone grit. For this purpose, the white and soft varieties should be chosen; the softer the better, provided the rock has sufficient cohesion to remain together till the blocks are laid in the furnace hearth, or wherever else they may be wanted. It is unnecessary to men-

tion particular localities, as firestone is associated with the millstone grit throughout its entire extent.

FIRE CLAY.

Nearly every workable seam of coal that I have seen, rests upon a bed of fire clay. Fire bricks might be manufactured in Tuscaloosa from a bed in the suburbs. The Govan fire-proof bricks of Scotland, that sell in Boston at $60 a thousand, are made of precisely such clay as we have in abundance.

FLAGGING STONES,

Of excellent quality, abound in the coal measures. A noted locality occurs on North River, at Plank shoals, a name derived from the form of the flags. In some places, flags form a considerable article of commerce.

MARBLE.

Beds of yellow marble, with black spots, are found in the carboniferous limestone, south of Huntsville. These have not been explored; indeed, the only marble in any part of the State, that seems to be at all valued, is the white marble, and that only for one particular purpose.

CHAPTER VI.

Cretaceous System.

Extent—Mineral composition and Geological structure—Section at Finch's Ferry—Section at Choctaw Bluff—Relative position of the beds of this section—Fossils—Physical features, and soils—Recapitulation.

Extent.—Did the cretaceous system of the State consist of calcareous beds alone, there would be but little difficulty in settling its precise limits; but the lower beds are made up of gravel, clay, and sand, containing some organic remains. When the latter, however, are absent, these beds can be distinguished with difficulty, from similar ones of a newer formation. Of this difficulty, it is sufficient to say, that the beds around Tuscaloosa, have been referred to the lower part of the cretaceous system,* although, as it will appear, they are newer than the white limestone of Clarke. A like difficulty occurs at the southern boundary of the cretaceous and tertiary formations, owing to the blending of the lower beds of the one, with the upper beds of the other.

The north-western extremity of the calcareous beds of the formation occurs in Pickens county, on the western bank of the Tombigby, which forms its eastern boundary as far as Warsaw. From Pickens, the cretaceous rocks extend into Mississippi, and thence to Tennessee.

Rotten limestone is exposed in the bluffs along the river, which has its channel at the juntion of calcareous and the lower silicious beds of the formation. It is no uncommon circumstance to find beds of rivers situated where two strata of unequal resistance meet, and hence it is a subject of common remark, that the soil and physical features of the country are often entirely different on opposite sides of the same streams.

* Jour. Geol. Soc. Lon., vol. 2, p. 280.

At Warsaw, the river cuts into the limestone which may now be traced from the ferry, at that place, to Clinton. An undulating line drawn from Clinton to Eutaw, and crossing the Warrior at Choctaw bluff, will mark the boundary, thus far, with sufficient accuracy.

It is seen again at Hamburg, in Perry county, and on the Eastern bank of the Cahawba, at the ferry; from this point it may be traced to Selma and some distance higher up the river. It appears again near Montgomery, where my examination terminated in that direction.

Towards the south, this bed disappears beneath the tertiary, on the creeks, a few miles below Prairie Bluff. on the Alabama river; and on the Tombigby, a little north of Black Bluff. The irregular belt included between these boundaries constitutes, what is known in Pickens, Sumter, Greene, Lowndes, Marengo, Dallas and Wilcox counties, as the prairie region; and although, but comparatively, a small part of it consists of prairies, it must, nevertheless, in an agricultural point of view, be deemed the most interesting portion of the State.

Along the northern edge of the calcareous deposit, the extent of which has just been indicated, and parallel with it, is a region of considerable extent marked by a hilly and somewhat broken surface. This includes the country between Foster's ferry and Eutaw, and the road between Carthage and Greensboro' passes over it. Where the rail road from Montgomery approaches the river, fine opportunities are presented of observing the lower beds of this region. They are not identical with those seen at Tuscaloosa, yet it is, for the reasons already mentioned, difficult to distinguish between them, and for the present their line of junction must remain in doubt.

Mineral Composition, and Geological Structure of the Cretaceous Rocks.

The coal measures which are laid bare, in the bed of the Warrior and tributary branches, at Tuscaloosa, dip totowards the south, and disappear beneath the cretaceous beds just mentioned, which are composed of loose sand, gravel, loam, and beds of dark colored clay, of very considerable thickness. The examination of a few sections, where they are exposed,

will place their relative position in a clearer point of view than a lengthened description.

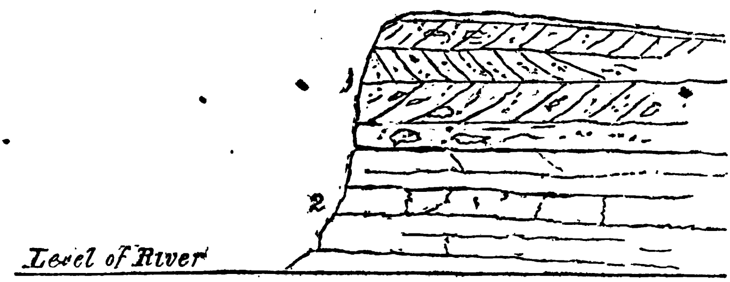
At Finch's ferry, near Eutaw, a perpendicular bluff occurs, which rises 80 or 100 feet above the level of the river; the slides that take place here, are constantly presenting fresh surfaces on the face of the bluff, so that it affords an excellent section for the study of the older cretaceous strata. The lower fifty feet is composed of a dark colored, fine grained laminated clay, resembling shale, but soft enough to yield readily to the knife; this forms the bed of the river, and is seen again higher up at Merriwether's landing, so that it must be of great thickness. It is called, by persons uninformed upon such subjects, soap-stone, a mineral to which, of course, it bears but a very remote resemblance.

Overlying this are thick beds of sand, having sufficient coherence to retain a perpendicular face, until the lower beds give way, when vast masses tumble or slide down. Portions of these beds are cemented by silica, so as to form pretty hard sandstone.

Silicified wood is not uncommon; but the most abundant fossil remains in these beds, consist of shark's teeth, of genera common to the tertiary. I was, for some time, puzzled to refer these beds to their proper place, until, at length, I had the good fortune to find a well preserved specimen of *Ammonites Delawarensis*, a characteristic cretaceous fossil, which removed every doubt.

SECTION ACROSS THE RIVER AT FINCH'S FERRY.

FIG. 13.



1. Beds of sand, obliquely laminated, containing silicified wood, Ammonites and remains of fishes.

2. Dark colored clay distinctly stratified; forming the bed of the river.

Farther up the river, other beds, composed of sand, loam and clay, come to the surface, which are covered by the section at the ferry. Abundant opportunities of examining these, present themselves every where to the north of the calcareous beds. The beds of the section exposed on the river, at the steamboat landing, at Montgomery, are identical with these, although the dark clay bed does not come to view, yet it may occur higher up the river. Casts of fossil shells are abundant, but difficult to identify. I found, however, a cast of a Pinna, which I afterwards found at Prairie Bluff. The sand is cemented by oxide of iron, and falls down in large blocks, from the encroachment of the river. About one half mile below the landing, a deposit of silicious iron ore, much mixed with clay and other impurities, occurs, which has assumed, by segregation, a variety of singular forms, such as plates, pipes, cylinders, &c., so that the locality presents the appearance of the ruins of an old forge.

From the river, the country rises to the edge of the rotten limestone, which comes to the surface a few miles from town,

where a quarry was opened in it for the supply of building stone, a purpose for which this rock is but indifferently fitted. The outcropping edge of the limestone overlaps a bed of yellow sand, which may be traced to Montgomery. I procured at this locality several cretaceous fossils of the genus *Ammonites*, together with the teeth of *Ptychodus Mortoni*, and other remains of fishes.

As I have already remarked, the structure of this formation can only be studied in the natural sections presented on the river banks; and no where can the relative position of the lower beds be seen to better advantage than on the Warrior, near Eutaw.

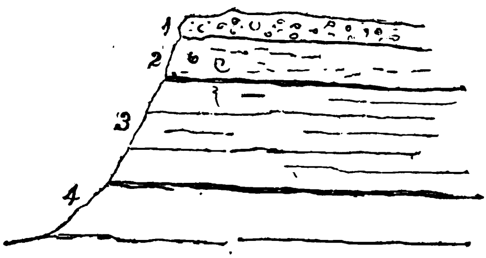
A few miles below Finch's ferry, the outcrop of the limestone is marked by the usual black soil of the prairies, and the rock is exposed in several bald spots to the right and left of the public road; it is white, soft, and broken by lines, bearing some resemblance to cleavage planes.

Fossils of a few genera, such as *Hamulus onyx*, *Gryphæa mutabilis*, *Exogyra costatu*, and *Mosas auroid* vertebræ, are found on the surface and embedded in the rock. Six miles below the ferry, at Choctaw Bluff, the first exposure of this rock occurs in a fine section 70 feet high, and about one quarter of a mile in length, but the river was higher than ordinary at the time of my visit, and I could only examine that part of the bluff above its surface. The upper 4 feet is composed of red loam, containing quartz pebbles: below this, is a bed of rotten limestone, or argillaceous marl, about 6 feet thick, containing the fossils just named, which I had seen where it thins out at the surface higher up. This is underlaid by a bed of bluish clay, 30 feet thick, which is laminated and studded, on the surface exposed, with nodules of iron pyrites.

Below this is a stratum of coarse loose marl, containing a bed of *Gryphæa convexa;* this is extended above the surface of the river about 8 feet. Fig. 14 represents a section at this locality.

Section at Choctaw Bluff.

Fig. 14.

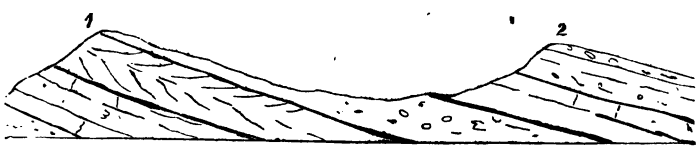


1. Loam, with quartzose pebbles, 4 feet thick.
2. White argillaceous marl, containing fossils, 6 feet thick.
3. Blue clay, 30 feet thick, laminated, and abounding in iron pyrites.
4. Coarse marl, containing *Gryphœa convexa*, 10 feet to surface of water.

The two preceding sections are parallel, or nearly so, with the strike of these rocks, which consequently appear horizontal. The strata at this place present an evident dip down stream, and as I had already traced their edges as they overlap each other, and those at the ferry, there remained no doubt of the relative position of the whole, as exhibited in Fig. 15.

Section from Finch's Ferry to Choctaw Bluff.

Fig. 15.



1. Rocks exposed at Finch's Ferry, and represented in Fig. 13.
2. Rocks at Choctaw Bluff.

The position of these, settled the geological structure of the rest of the cretaceous formation, and the phenomena dependent on it, offered but little difficulty.

Between the Bluff and Eutaw, and at the junction of the calcareous and silicious beds, the remains of cartilaginous fishes are numerous. At the village, Judge Thornton pointed out to me a locality where we found detached and water-worn masses of limestone embedded in the loam and sand which cover the surface, but which is excavated by a little stream at that point. This is plainly the edge of the great calcareous formation, occupying the surface lower down. A few casts of fossil shells, and the teeth of fishes, were the only organic remains noticed here.

About a mile from this, the calcareous deposit of that portion of Greene, included between the Tombigby and the Warrior rivers, called the "Fork," commences; the beds thicken rapidly, as is exhibited in the deep borings for water, and are surprisingly uniform in mineral character; whilst the absence of streams and ravines, added to the unbroken surface of the entire region, renders the study of the underlying rocks extremely difficult, so that it becomes at once evident, that the geologist who would work out the structure of the cretaceous formation of the State, must confine himself principally to the natural sections presented in the river bluffs.

For many miles, the surface is slightly undulating, and almost the only change that could be perceived in the limestone, presented itself in the ledges of rough and rather hard rock, which occasionally occur on the brow of the slight elevations of surface scattered over the country. This rock has the appearance of having been perforated in all directions, which suggested the name "bored rock," by which it is known here; it is sufficiently hard to be sometimes employed for repairs on the public roads, and I saw in front of Col. Thornton's residence, a substantial fence composed of it. Where it lies upon the surface, constantly exposed to the absorption of moisture, I observed, elsewhere, that it was subject to disintegration; but this fence, after a trial of three or four years exposure to atmospheric changes, showed no signs of decay. Should this experiment prove successful, when tried upon a large scale, it will be of no small importance to the planters of that region,

to have within their reach the means of constructing cheap permanent fences.

The rock contains more lime than the mass of rotten limestone of the bluffs. It was not before I had examined the section at Arcola, that I was enabled to explain the cause of the bored appearance, which it every where presents. The upper part of the bluff at the last mentioned locality, is composed of a mottled and indurated marl; the white and more calcareous portion, forms the base, which is pierced in every direction, with cylindric and variously shaped nodules of argillaceous matter, much softer than the rest of the rock, and they are for this reason washed out by the rains, giving the rock this remarkable structure.

The tendency of clay to assume, under certain conditions, a variety of curious forms, is well known, although the law governing the phenomenon is not yet well understood. We know, however, that where several substances are blended in the same mass, that if freedom of motion among the particles exist, they will unite according to the laws of affinity; it is in this manner that the nodules of sulphuret of iron are formed, which are are disseminated through the cretaceous marls and limestones.

The whole of what is called rotten limestone once existed in the state of soft mud, a sedimentary deposit formed gradually at the bottom of a deep sea, and hence the remains of marine animals and shells found in it. Under these circumstances, the calcareous particles united to form the mass of the limestone, whilst the argillaceous particles, formed by segregation around centres, produced the embedded and irregular nodules which, when washed out, give the singular appearance alluded to. A peculiar feature in the geology of the "Fork," consists in the numerous isolated conical hills scattered over the country; they are composed of sand, pebbles and clay, and if they did not present indubitable evidence of their origin, one might mistake them for artificial mounds on a magnificent scale. They give rise to springs, the water of which is free from the usual impurities of the limestone, and furnish, in many other respects, desirable sites for the residences of the proprietors of the land. Differing so entirely from the rest of the country, it is not surprising that these elevations should have excited attention, and given rise to speculations as to their origin.

The lower beds of this region are finely displayed at Jones's Bluff, on the Tombigby, where a vertical section 100 feet in height, and one half mile in length, is exposed on the western bank of the river.

The rock is here, as elsewhere, a nearly homogeneous mass of rotten limestone, that weathers white on the surface by exposure, but when recently laid bare, it is of a dark gray or bluish color. At different elevations, along the face of the bluff, strata occur that are rather more indurated than the rest, and stand out, exhibiting planes of stratification, and indicating a slight southern dip. In the fissures of the bluff, veins of that variety of calcite called dog-tooth spar occur, and nodules of sulphuret of iron beautifully crystalized on the surface, are disseminated through the rock, giving out in the sun's rays very strongly the odor of sulphur.

The face of the bluff is curiously indented by deep ravines, excavated by the surface water, which flows over the edge, leaving portions jutting out into the river, which give it a castellated appearance, and these snowy projections standing against a back ground of dark green foliage, makes this one of the most picturesque bluffs on the rivers in the lower part of the State.

Sections made up of this rock may be seen at Erie, and still lower, at Dr. Withers's mills. On the eastern side of the river, fossils are more abundant, and at the last named locality, I found the following:

Inoceramus Barabeni.	*Ostrea cretacea.*
Gryphœa mutabilis.	*Trigonia thoracica.*
Cardium.	*Hamites torqueatus.*
Hamites arculus.	*Natica petrosa.*
Pecten 5-costatus.	*Hippurites.*

And numerous remains of fishes.

Between this and Arcola, an extensive prairie once existed, but as it is now in cultivation, it has of course lost all its natural features. The surface is gently rolling, and interspersed with bald white spots, from which the soil has been washed away, and which give a little variety to the landscape.

The channel of Big Prairie creek is excavated in the under-

lying rock, and presents some interesting localities abounding in fossils. At one of these, near Lafayette bridge, I found *Hippurites*, *Hamulus onyx*, *Ostrea plumosa*, *Exogyra costata*, with teeth of *Lamna*, and vertebræ of osseous fishes.

At Arcola a high bluff is formed by a sweep in the river, where the cretaceous rocks are exposed to a depth of 80 feet. Ten feet of the top is composed of rather hard and whitish mottled limestone, which when the soft portions are washed out, presents the appearance of the bored rocks of Greene.

Immense fragments which have fallen down, strew the base of the cliff. Towards the upper end of the bluff, this bed thins out and disappears entirely, and the underlying thick bed occupies the surface.

This bed is 60 or 70 feet thick and made up of the common blue argillaceous rotten limestone, which is as usual laminated, but is much broken up by fissures. The face of the bluff is concave, indicating the variable abrading force of the water by which it is wasted.

Casts of *Inoceramus*, are common in the argillaceous beds, but fossils are more abundant wherever sandy seams are found. The remarkable fossil called *Hippurites* which in this country, is confined, so far as yet known, to Alabama, occurs at this locality in a fine state of preservation.

The streams, between Arcola and Demopolis, have excavated their deep and narrow channels in this rock; and at the latter place the fine bluff at the landing is composed of it. Towards the ferry, a thick bed made up of sand and pebbles, including water-worn fragments of soft limestone, covers the rotten limestone on the bank of the river. The only fossil I could find in this was Hamulus onyx.

Between Demopolis and Prairieville a series of rounded white knolls, covered with cedars, give a pleasing variety, when contrasted with the dark monotonous surface of, what is called the "cane brake." The bleaching of this rotten limestone by weathering is here remarkable; below the surface, it is of a dark gray color; but on any slight elevation, where it is completely drained, and exposed to the atmosphere and light, it becomes nearly as white as chalk.

The absence of trees, so uncommon in this country out of the prairie region, gives the country around Prairieville, not-

withstanding the excellence of the soil, a naked and cheerless aspect. I found here for the first time *Terebratula floridana*, associated with the more common cretaceous fossils.

From this place to Woodville, the public road passes through the "cane brake" proper; in geological structure this interesting region differs but little from the middle portion of the cretaceous formation; its physical features and soil will be described in another place.

Around Athens the post oak prairie soil predominates, and its peculiar subsoil is deeper here than I have observed it elsewhere; it seems indeed, to be deposited in the depressions on the surface of the limestone which is found protruding through it, forming the usual white spots, almost bare of soil.

I owe, to the politeness of Mr. Elerbe, a knowledge of some of the most interesting localities of fossils that I have seen, which occur in the vicinity. At one of these, the animals, whose remains are found, must have lived and died on the spot. The shells have their valves in juxtaposition, and their most delicate parts completely preserved; a circumstance not common among the cretaceous fossils, which are, for the most part, mere casts of the interior of the shells, although the casts of bivale shells show very plainly that the animals, with their calcareous coverings, were entombed, whilst living, where we find them. No one could examine one of these localities for five minutes, and come to any other conclusion.

Among the fossils, finely preserved, and having both valves together, were *Exogyra costata*, *Gryphæa mutabilis*, *Plicatula*, *urticosa*, *Placuna scalra*, *Ostrea plumosa*, *and Ostrea falcata*.

Large vertebra of a mosasauroid animal are also among the organic remains of this place.

In the direction of Cahawba, rocks of this description sink beneath the tertiary beds, made up of red loam and water-worn quartz pebbles, the character and position of which may be seen at the bridge across Bogue Chitto creek. The section here is about 35 feet in height, the upper 15 of which is made of the silicious beds, just mentioned; under these, is one of rotten limestone, which exhibits, at its base, where it is washed by the stream, the irregular perforations explained elsewhere.

Between the creek and the Cahawba the country is remarkably level; its flora had, to me, a tertiary aspect, and bore a

strong resemblance to that of the lower part of South-Carolina and Georgia. Among the most conspicuous of the plants were *Liatris odoratissima*, and other species of that showy genus. It was refreshing once more to breathe an atmosshere rendered fragrant by its passage through a forest of long leaf pine.

On the Alabama river, at Cahawba, the bed of brick-red sand and loam, with pebbles, occurs; it is about 25 feet in thickness, and the wells which supply the town with water are sunk in it ; it is underlaid by the rotten limestone, presenting nothing to distinguish it from the usual form of that rock.

The bluff, upon which the town stands, extends from the mouth of the Cahawba river, a considerable distance down the Alabama, and re-appears again about two miles lower; it is, at this point, almost perpendicular, and a number of bold springs gush from the superincumbent porous beds. The organic remains found here are not numerous ; they consist of *Inoceramus*, *Exogyra*, *Hippurites*, and *Ammonites placenta*.

On the eastern side of the river, the cretaceous rocks are seen, beyond the low grounds, on the brow of the hills, where they are found cropping out from under the silicious beds that occupy the surface of the eastern side of the State.

The most striking feature in the rocks under consideration, is the extraordinary uniformity of their mineral composition. I have traced them over a distance of 150 miles, and the only important change that I can discover in the calcareous beds, is the occasional predominance of lime on some of them over others, which produces a greater degree of induration, so that, as a general rule, that may have some practical value, the harder the rock the more lime it contains. And even in the deep borings of artesian wells, there is but little change perceived beyond the occurrence of sandy beds, that render tubing necessary in the boring operations.

I have specimens brought up by the auger from a depth of 640 feet, which differ from the surface rock, in being a little more silicious and indurated.

On the way from Cahawba to Prairie Bluff, I crossed Bogue Chitto again, where it has cut out a deep, and narrow channel, which is so so regular as to suggest the idea of an artificial canal. Beyond this, the surface is covered with red loam to within three miles of the bluff, where a marked change occurs in the

cretaceous rocks. In an excavation, near a little stream that flows into the river two miles north of the bluff, an interesting section occurs, where the edges of the beds, so finely developed at the bluff, come to the surface; the upper part of the section is occupird by a bed of buff-colored sand, 20 feet thick, containing *Exogyra*, and other characteristic fossils. This is underlaid by a thick bed of dark sandy loam, somewhat hard, and containing a vast number of *Ostrea falcata*, and *Pecten 5-costatatus*. The upper bed is continued to Prairie Bluff, occasionally interstratified with seams of hard limestone, and may be seen on the hill tops which are covered with cedars.

The top of the bluff consists of a hard limestone filled with *Exogyra costata*, and casts of other species. It is seen again about one mile west of the bluff, on Shell creek, where it is equally rich in fossils. This part of the cretaceous formation has furnished nearly all the fossils that have been described and figured from Alabama.

Below this bed is a thick stratum of sand, with indurated bands running through it; and this is underlaid by the dark colored silicious bed which I had already seen thinning out higher up, but which has here assumed the character of hard rock.

Above the bluff, the river has receded from the high grounds; but the thick sandy bed may be traced a mile higher up the river. Another interesting locality occurs about one mile higher, at a place called Rocky Bluff; the yellow sand is on the surface with hard layers passing through it, as at Prairie Bluff. This bed is filled with *Pecten 5-costatatus* in a fine state of preservation. The dark bed is also well developed, and abounds in *Ostrea falcata*. Near the edge of the water, masses of sandstone, the ruins of the bluff, are scattered about in confusion, and curiously weathered on the surface.

After crossing the streams near the ferry, below the bluff, the cretaceous rocks sink beneath the surface, or become blended with the lower tertiary beds as they lap over them.

On the Tombigby, the first decided cretaceous rocks that I saw, occur on the Suckanoche, above Black Bluff; from this to Livingston they are seen occasionally protruding above the surface sands, but around the town they are developed where the superincumbent sandy beds are removed. The town itself

stands on a plain composed of loose sand, loam, &c., and resting on the rotten limestone. This is precisely similar to the little hills of Greene, excepting that the denudation did not proceed far enough to reduce it to a cone. For the fossils comprised in the following list, I am indebted to Mr. J. F. Williamson, of the senior class in the University, who collected them from the cretaceous rocks around Livingston:

*Belemnites Americanus.**	*Nautilus Dekayi.*
Ammonites Conradi.	*Baculites carinatus.*
Hamites torquatus.	*Trochus leprosus.*
Turritella vertebroides.	*Scalaria Sillimani.*
Rostellaria arenarum ?	*Ostrea falcata.*
O. plumosa ?	*Gryphæa mutabilis.*
G. vomer.	*Exogyra costata.*
Placuna scabra.	*Pliccatula urticosa.*
Cucullæa vulgaris.	*Trigonia.*
Serpula barbata.	

From Livingston to Gainesville, the country is much broken, and cretaceous marl and limestone are every where seen on the surface, characterised by *Exogyra costata.*

At the steamboat landing, Gainesville, a good section may be seen, in which the relative position of the silicious surface beds and the underlying limestone may be studied. I owe to the politeness of Mr. Cooper, specimens from various depths of the Artesian well at that place. The only thing remarkable in this section, is the occurrence of a thick bed of green sand, at a depth of 600 feet. The last stratum bored into, consists of tenacious clay, very much like the thick bed at Finch's ferry, on the Warrior, and in general, the lowest beds penetrated, contain scales of mica in greater abundance than I have elsewhere seen them in the cretaceous beds of the State.

Between Gainesville and Jameston, the limestone is concealed by the superincumbent silicious beds. West of the lat-

* This, I believe, is the first notice of the occurrence of this fossil in Alabama.

ter place, it occupies the surface, presenting the counterpart of the canebrake, with its slightly undulating surface, and deep, black, and rich soil. Besides the ordinary cretaceous fossils, fine specimens of *Hippurites*, *Ammonites Delawarensis*, and *Ammonites placenta*, of very large size, are found here.

The following list includes all the fossils that have been collected from this formation:

Mosasauroid, vertebræ.
Lamna, teeth.
Otodus, teeth.
Testudo, (*carapace.*)
Corax, teeth.
Ptychodus, teeth.
Ammonites placenta.
Ammonites Conradi.
Ammonites Delawarensis.
Ammonites Syrtalis.
Bacculites ovatus.
Bacculites carinatus.
Bacculites asper.
Bacculites labyrinthicus.
Hamites arculns.
Hamites trabeatus.
Hamites torquatus.
Trochus leprosus.
Turritella vertebroides.
Scalaria Sillimani.
Rostellaria arenarum.
Rostellaria pennata.
Natica petrosa.
Natica abyssina.
Ostrea falcata.
Ostrea plumosa.
Ostrea cretacea.
*Ostrea subspatulata.**
Gryphæa convexa.
Grgphæa vomer.
Gryphæa mutabilis.
Exogyra costata.
Pecten 5-costatus.
Anomia argentea.
Placuna scalra.
Plicatula urticosa.
Inoceramus Barabeni.
Inoceramus alveatus.
Cucullæa vulgaris.
Crassatella vadosa.
Terebratula floridana.
Hamulus onyx.
Trigonia thoracica.
Venelia Conradi.
Serpula barbata.

This is not the place, to enter into theoretical speculations as to the origin of this formation; suffice it to say, that it is altogether composed of marine sedimentary deposits, formed at

* I found a single valve of this fossil at Prairie Bluff.

the bottom of a deep sea; that the organic remains are all marine, and belonging to animals that have long since passed out of existence, and have not left a single living representative behind. These beds have been raised up, by an immense force acting from below, and converted into dry land.

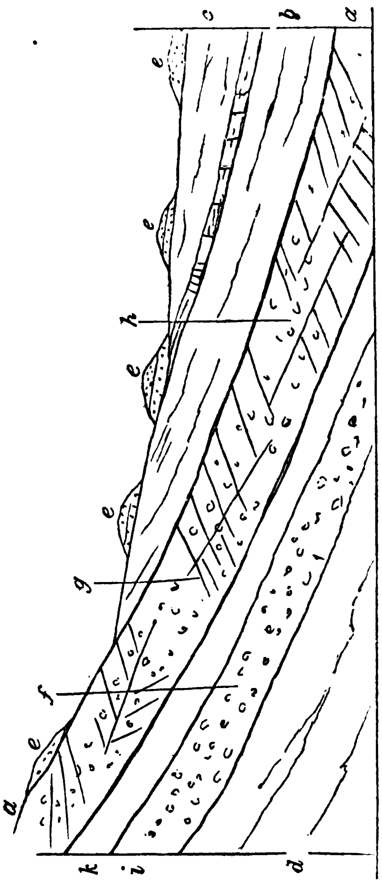
Physical Features and Soils.

From what has been already said, there will be but little difficulty in understanding whatever peculiarities there may be found in the physical features and soils of the prairie region of the State. A section, showing the relative position of the principal strata of the cretaceous rocks, and their relation to the coal measures upon which they rest, and to the overlying tertiary rocks, will render the subject quite plain.

The following section extends from Finch's ferry to Clarke county:

SECTION SHOWING THE RELATIVE POSITION OF THE CRETACEOUS AND TERTIARY ROCKS.

FIG. 16.



a—Bed of sandy materials seen at Finch's Ferry.
b—Rotten limestone.
c—Tertiary beds.
d—Coal measures.
e—Conical hills of sand and gravel.
k—Black shale.
i—Lower bed of sand.
f—Artesian well at Finch's Ferry, above the edge of the limestone.
g, *h*—Artesian wells in the limestone.

It is more probable that the beds *e*, *e*, *e*, were once spread over the whole prairie region, than, that they could have been deposited in the isolated patches in which we find them. Had this sandy stratum remained continuous, instead of being removed again by denudation, it is obvious that the whole region would have a soil like that found on the little hills of Greene, and on the spots upon which Livingston and Cahawba stand.

There are scarcely any other phenomena more familiar to the geologist, than those resulting from denudation. Hills and valleys are produced by denudation; nearly all the irregularities of surface in Alabama are due to this force. Nor would those of the surface of the cretaceous formation have excited the attention of observers, but for the fact of the great contrast between the superincumbent sandy beds, and the rotten limestone. Every one is familiar with the wasting away of the surface by exposure to atmospheric agencies. Within the memory of some of the citizens of Tuscaloosa, ravines have been excavated by the rains alone, equalling in depth the height of the hills in Greene; so that there can be no difficulty in conceiving, how in the lapse of time whole strata may be removed.

The steep banks of the rivers that flow through the cretaceous formation, present sufficient evidence that they have scooped out their narrow, deep channels, in the rotten limestone. The surface water draining towards the rivers, would carry with it the loose surface materials, until it reached, like the rivers, a more indestructible bed.

Many of the little hills alluded to, have the appearance of having been once united in a continuous ridge: this is the case with four or five of them at Patton's hill, in Greene, which occur in a row. The question next arises, why should not the whole stratum have been removed? Why are some isolated patches left? It is not always easy to answer such questions as these, because we do not know the original condition of the surface. We know, however, that hills of denudation are often due to the circumstance of their being protected by having upon their summits beds not equally subject to wasting with the rest. The elevations in the pine-covered hills above Tuscaloosa, are the result of the protection afforded by beds of highly ferruginous sandstone, with which they are capped. The hills around Huntsville are capped with beds of indestructible millstone grit, by which the underlying limestone is protected. Even a bed of pebbles is often sufficient to protect the less coherent beds below. Many of the bald knolls on the prairies are due to beds of harder limestone, and I observed the "bored rock" more frequently on elevations, than elsewhere.

The denuding force of water is made up of its velocity and

volume; as either of these is diminished, of course, its wasting force is lessened, and hence its effects are less, as the surface over which it passes approaches a level, and hence, too, the action upon elevated points, is abated in proportion as they contract their surface, as less water falls on them. It is for this latter reason, that conical hills so often remain monuments to attest the amount of depression that the general surface has suffered by denudation.

If these simple facts be admitted, there will be but little difficulty in accounting for the physical features of the prairies. If a part of the stratum *e*, *e*, be removed in places down to the bed of the limestone *b*, we shall have, in time, the portions left converted into the little conical eminences, *c*, *e*, while the rest of the surface will be covered with true black prairie soil, derived from the rotten limestone. Now the reason of the abrupt changes of soil, also becomes evident: as soils are derived from the underlying rocks, when those change a corresponding change must occur in the soil; thus in passing from the sandy bed to the limestone, a soil entirely different will be found. These changes are common to all countries, but are rendered more striking here, from the broad contrast which they present. The soils derived from the lower beds at *a*, like all soils having for a suh-stratum, clay, loam and sand, will vary with the predominance of one or the other of these. Besides, they are influenced greatly by the physical features of the surface. The region occupied by these beds, as I have elsewhere stated, is an irregular belt extending across the State, immediately to the north of the calcareous bed, and is the most hilly and broken part of the State, south of the first falls of the rivers.

The surface of the country, underlaid by the rotten limestone, is but little diversified; it is, however, occasionally broken into rounded bald knolls, as may be seen between Arcola and Demopolis, and between Livingston and Sumterville. The summits of these hillocks are sometimes ornamented with cedars, but more frequently, they are quite bare, or covered with but a scanty vegetation; even where the surface is but slightly undulating, bald spots occur where the naked rock has come up. But the most remarkable feature of this region is the extensive tracts of land covered with a deep, black, soil of great

depth, and extraordinary fertility, which may be seen in various parts of Sumter, Greene, Marengo, Perry, and Dallas, but more particularly in the 'cane brake.' The surface of these remarkable tracts has, barely, sufficient inclination to admit of easy drainage, without giving the water force enough to remove the soil, so that, instead of excavating a channel at the bottom of the trough-like depressions where this sort of land occurs, it is absorbed by the soil, or spread over a considerable space, where it loses all transporting power. This is strikingly illustrated, at Boligee, where, towards the head of one of these broad and shallow valleys, I observed a channel partly artificial, and partly natural, excavated for the purpose of conveying off the surface water, which I supposed would necessarily increase in depth and capacity, as it received more of the drainage water, as it approached the lower end of the valley—but I was not a little surprised to find that, instead of this, as the declivity of the surface lessened, the channel almost entirely disappeared, the water having spread itself over the surface.

The unbroken surface of this region, is due to the homogeneous character of the limestone, which suffers waste equally on this account, over considerable areas; and hence the entire absence of ravines, and other abrupt irregularities. The effects of this feature upon the soil must be obvious; nothing escapes, every particle of organic matter remains upon the surface, or is removed but a short distance, to be again deposited. A soil formed under such circumstances, and from such a material as this, rotten limestone can not fail to possess extraordinary fertility, as must appear from the analysis of that rock:

Carbonate of lime	42·25
Silica	23·00
Alumina and oxide of iron	31·00
Phosphate of lime	·05
	99·30

We have here all the important inorganic elements of a good soil.

Besides the action of lime in promoting the decomposition of

vegetable matter, it imparts to the soil important physical properties, which greatly add to its fertility.

All calcareous soils stand high in relation to the power of both imbibing and retaining moisture; the hygrometric property, or the power of absorbing moisture from the atmosphere is also very considerable in such soils. The effects of these properties are strikingly illustrated, in the uncleared parts of the cane brake, where one can scarcely satisfy himself that he is not standing on the low grounds of a river; the deep, alluvial-looking soil beneath his feet, the moisture-loving long moss (*Tillandsia usneoides*) above his head, together with an undergrowth of *Sabals*, *Palmettoes*, and other natives of damp soils, strengthen the illusion.

But the traveller who visits this region after a rainy season, will stand in but little need of illustration of the retentive power of prairie soil. Little can he imagine that the smooth road, level as a bowling green, and glistening in the sun from very polish, over which he passes, may, in an incredibly short time, be converted into a mass of clay sufficiently soft to allow his wheels to drop down to the axle, but having a tenacity that no clay ever had.

Situated, as these lands are, with navigable streams to the right and left, they could not fail to be fully appreciated. They are, consequently, nearly all in cultivation, so that it is difficult to conceive what appearance the country presented, to the early settlers. Considerable tracts were entirely destitute of trees, and covered with tall grass, and a profusion of showy, flowering plants.

The absence of trees on prairies, has excited some speculation, and has been attributed to different agencies.—Among the uncultivated spots of the cretaceous formation of Alabama, there are spots without trees, but the cause is quite obvious: they are elevated spots, where the soil is washed away by every shower of rain, so that the little organic matter derived from the scanty herbage growing on the spot, disappears in this way, instead of remaining to produce a soil; and it is difficult to conceive of localities more unfavorable to the growth of trees. But in the vicinity of these barren spots, wherever soil has accumulated, trees have taken

possession, and it was curious to observe their gradual encroachment, with the persimmon tree at their head.

But the absence of trees upon the rich soils of the prairies, is more remarkable, yet it appears to me, not more difficult of explanation. Any cause sufficient to prevent the growth of young trees from the seed, will produce, in time, a prairie, no matter what may be the character of the soil. The most probable cause of this seems to be the annual burnings, practised by the Indians, to facilitate hunting, and traveling about; that this was their practice, we have the evidence of those who lived amongst them.* The same practice prevails amongst the white inhabitants of the thinly settled parts of the country, for the purpose of removing from woodland, and other pastures, the dead vegetable matter of the preceding season; and I have seen pine woods, that have been subjected to this treatment, in a fair way to become prairies. The heavy growth of sedge-grass burned off in spring being quite sufficient to produce heat enough to destroy the young trees, just starting from the seed, and often those of some size. Of course this effect can only follow where the grass and undergrowth is in considerable quantity; and it is for this reason that rich limestone soils are more frequently prairie, than those that are less favored; the luxuriant crop of grass, and other plants, furnish combustible matter sufficient to prevent the usual succession of young trees. But where this cause is removed by the discontinuation of the practice alluded to, trees soon take possession,—but even then, trees having heavy seeds, such as the oak, must spread slowly, unlike the pine, which has seeds furnished with wings, and capable of spreading over considerable areas in a short time.

SPRINGS.

As springs are due to the alternation of porous and impervious beds, the one allowing water to percolate through them, and the other serving as a reservoir to retain it, it is obvious that none can exist in a stratum so homogeneous, and free from

* Silliman's Journal, vol. 2, p. 30.

joints and fissures as the rotten limestone, and for the same reason, there can be no permanent streams. Those springs called "seap-wells" are supplied by rain, percolating through the soil; and flowing along the surface of the limestone beneath, the water is received into any excavation or depression that may occur. Water thus flowing through a soil abounding in vegetable substances, must contain much organic matter in solution, and hence, it tastes more like a vegetable infusion, than spring water. To obviate this, the planters construct artificial reservoirs in the limestone, into which rain water is conducted from the roofs of houses. These reservoirs are made pitcher-shaped, and of very considerable capacity; and so impervious is this rock, that very little is lost by leakage. Sulphuret of iron is disseminated through the limestone in great quantity, and the water of the cisterns, from this cause, often becomes strongly chalybeate, and sulphurous. Lime is also very generally present. This could be very effectually prevented by a lining of brick, laid in hydraulic cement, and plastered with the same material.

Artesian wells, when practicable, have also been bored, to supply the deficiency of natural springs. A glance at the section (Fig. 16) on page 132, will show how admirably the geological structure of the formation is adapted to this mode of procuring water.

The porous bed *a*, exposed above Finch's ferry, being the water bearing stratum, the water is prevented from descending by the bed of clay, *k*, and from coming to the surface, by the limestone, *b*. Now, if the latter be perforated, as at *g*, *h*, of course the water will rise by its static pressure, and if the surface at *g* and *h* be lower than *a*, it will overflow; if not, it will only rise to a corresponding level in the well.

I was surprised to find, at Finch's ferry, two Artesian wells, beyond the edge of the limestone. An examination of the section on the river, explained the source of the water of these wells. The thick bed of clay, *k*, in the section, is perforated, till the underlying loose silicious bed, *i*, is reached, which is the water-bearing bed of these wells.

The water of nearly all that I have examined, is more or less highly charged with salts of lime, magnesia, soda and iron, and in some instances, it is impr[illegible]hur.

A steam engine at Finch's ferry is supplied from one of the wells just mentioned, and so highly is the water charged with salt, that wherever a leak occurs in the boiler, a quantity is collected by the negroes for domestic use. Dr. Withers' steam mill is supplied in a similar manner, and the evaporation of the water at the leaks in the boiler, leaves a substance containing common salt, sulphate of magnesia, and lime, with a trace of iron. The water at Finch's ferry, however, is the strongest that I have examined. There can be no doubt, that if these wells were not so numerous, they would become places of resort, as mineral springs; but 40 or 50 found in a county, places the matter out of the question.

Persons accustomed to this water, like it, and cattle prefer it to every other. For simplicity of the apparatus, and its entire adaptation to circumstances, and the object to be attained, as well as for the ingenuity displayed in its use, the well-boring of Alabama stands unrivalled, perhaps, in the world. The diameter of the bore is from 3 to 4 inches, and the quantity of water vented varies between 16 and 360 gallons per minute. The temperature of the water, as it issues from the spout, increases nearly with the depth of the well; but of course this gives only the mean temperature of all the water that flows into the well, and not that at the bottom. The want of uniformity in the results obtained, are doubtless due to this cause, and these results are, therefore, offered only as a coarse approximation.

TABLE *exhibiting the depth and temperature of the wells examined.*

	Depth feet.	Tem.
Well at Finch's ferry	173	64°
" " near mill	193	66°
Dr. Withers' mill	285	64° 30'
" "	360	65°
Boligee	415	68°
Dr. Withers' mill	420	66°
" "	468	66° 30'
Cane-field, Boligee	522	70°
Capt. Johnston's	560	71°
Dr. Perrin's	544	72°

Taking the wells of greatest and least depth, and comparing the temperature, it appears that the rate of increase is equal to 1° Fahr. for every 55 feet of depth.

These results were obtained with the same thermometer, by plunging it into the water before it issued from the spout, and noting the scale while the thermometer remained immersed.

The deepest well that I saw was about 740 feet, but I was informed that deeper borings than this have been made in the State.

The depth is uniform in lines parallel with the outcrop of the limestone, but increases, uniformly, at the rate of 25 feet to a mile in lines at right angles with that direction; that is to say, the farther from the outcrop, the deeper the well—a fact of practical value; and places in a strong point of view, the importance of geological maps, on which are delineated the boundaries of the various formations, included within their limits.

Post-Oak Prairies.

The stratum from which the soil of the post-oak prairies is derived, it is probable, was never continuous, but was deposited, as I have already said, in depressions on the surface of the limestone, after the latter had been subject to denudation. It is composed of clay and lime intimately mixed, producing a sub-soil of a light-brown color, that is subject to crack by contraction when drying. The name is derived from that of the common oak (*Quercus obtusiloba*,) of the region, which loves this peculiar soil.

The relations of plants to soils is an exceedingly interesting subject, and in limited districts, the indications of the nature of the soil derived from the plants growing upon it may be quite reliable, but over a wide extent of country, they must be received with caution. No one who has seen the sedge-grass in lower Virginia disappear before the application of marl, would expect to find the same plant growing on the bald prairies of Alabama; nor would any one who knows the soils upon which the "black-jack" grows in Virginia and North Carolina, fail to be surprised at finding it to flourish on some of the best prairie soils. Yet such is the case; and I think that the indications presented by these trees, point rather to the retentive

power of the soil in relation to moisture, than to the other conditions of fertility.

The soil of the post-oak land is stiff and tenacious; it is every where good, and by many considered more reliable in relation to the cotton crop, than the dark-colored and more fertile soils of the "cane-brake." I have found no fossils in this stratum, and hence refer it, with hesitation, to the cretaceous rocks. It may yet be found to be a mixture of the upper part of the limestone, with the lower tertiary beds.

The great depth of the prairie soil, added to its other properties, must for a long time, under judicious treatment, prevent the consequences arising from the cultivation, in succession, of a single plant; but the nature of the sub-soil, and the peculiar features of the surface, as well as those other qualities upon which the soil is dependent for fertility, render thorough draining imperative. I have rarely seen a country, where this simple mechanical means of improving the soil produced such effects, and where the results of its neglect were more obvious. But after all, sooner or later, exhaustion must follow the present practice of producing a single crop without rest, or intermission, upon the same soil, and without adding any thing to compensate for the enormous drain of from 300 to 500 pounds of cotton to the acre. The nature of the substances extracted by this crop from the soil, will appear from the following analysis by Prof. Sheppard:

	C. Wool.	C. Seed.
Potassa	31.09	19.40
Lime	17.05	29.79
Magnesia	3.26	trace.
Phosphoric acid	12.30	45.35
Sul. acid	1.12	1.16
Chlorine	traces.	traces.

This table exhibits the composition of the ashes of both wool and seed; and as the ashes of the wool is equal to 0.9247 per cent., it will be easy to calculate the quantity of these valuable ingredients abstracted from the soil by every crop—ingredients that can only be restored to it through the medium of manures.

RECAPITULATION.

1. The cretaceous system of Alabama consists of strata of loose sandy beds of laminated clay of dark color, and a deposit of soft argillaceous limestone.

2. The sand and clay constitute the lower series upon which the limestone rests, and comes to the surface along the upper edge of the calcareous beds. The sandy strata of this series form the great reservoir for the water of the Artesian wells.

3. The next stratum above these is the remarkable one called rotten limestone, which is composed of carbonate of lime, clay and sand. It is extremely uniform in its composition, and is at least 1000 feet in thickness. It is quite impervious to water, and reservoirs for rain water sunk in it, require no lining or other contrivance to prevent the escape of the water. It dips towards the south with a very small angle, and is perforated by nearly all the Artesian wells in the State.

4. This bed passes into sandy strata towards the top of the series, as may be seen at Prairie Bluff. I have not yet been able to indicate the fossils peculiar to these divisions of the cretaceous rocks. In general, the lower beds contain more remains of fishes; the middle contain the remains of reptilia, and Prairie Bluff is the only locality at which I have found Gryphœa vomer and Ostrea Subspatulata.

5. The exceeding uniformity of the rotten limestone has affected the physical features and soils, of the entire region, in a most remarkable manner, giving rise at the same time to a gently undulating surface, and a soil of great fertility.

6. The superficial beds scattered over the region in isolated patches belong to another formation, which once over-spread the country to a greater extent, but which has been reduced to the form in which we find it by denudation.

CHAPTER VII.

Tertiary System.

Extent—Mineral composition and structure—Buhr-stone formation—Green sand and lignite—Claiborne—White limestone—Organic remains—Post pliocene—Recapitulation—Marl and its application—Mineral springs.

Tertiary System.—The rocks of this system have long been better known to geologists, than those of any other portion of the geology of the State. Among those who first directed the attention of geologists to the tertiary rocks of Alabama, we find the names of the Hon. J. G. Creagh, Judge Tait, and A. B. Cooper, Esq., of Claiborne; and the first notice of the fossils of the State is due to their interest in the progress of science. Since then, the most important points have been examined by geologists, and there are no localities in America better known than Claiborne and St. Stephens; the former having furnished a large proportion of all the eocene fossils known in the United States, which have been described by Conrad and Lea.*

The mineral composition and appearance of the white limestone or marl of St. Stephens, as well as the supposed peculiarity of some of its fossils, caused it to be referred to the cretaceous system, an error which was corrected by Sir Charles Lyell during his last visit to this country; and these beds are now known to belong to the upper part of the eocene.

Extent.—The tertiary formation of the State overlaps the southern edge of the cretaceous formation, in its entire extent

* The "Contributions to Geology" of Isaac Lea, Esq., contains the best, and most accurate figures of American fossils that have been executed in this country, up to the date of Hall's Palæontology. The fossils figured are nearly all from Claiborne.

across the State: its northern boundary will therefore be an irregular line, extending from the lower part of Sumter on the west, crossing the Alabama river near the mouth of Dickson's creek, and thence across to a point above Fort Gaines, on the Chatahoochee. This line is not very well defined, and it will require some time to designate it with precision. I have not yet examined the southern part of the system, and can therefore say nothing of its junction with the Post Pliocene of the Gulf of Mexico.

Mineral composition and Geological structure.—A few miles southwest of Prairie Bluff, a very marked change may be observed in the face of the country. As the Dumas settlement is approached, the surface becomes broken, and the long-leaf pine is almost the sole occupant of the high and sandy ridges.

Along the State road, the physical features of the country are such as could not be mistaken by any one who had studied the tertiary of North or South Carolina. The same magnificent growth of pines, and the same sandy surface, scarcely concealed by the tufts of harsh wiry grass.

About two miles north of Choctaw Corner, the surface beds are removed by the streams that flow into Horse creek. These little rivulets are shaded in their course by groves of magnolias of striking beauty, of which superb genus three or four species may be seen together: *Magnolia grandiflora*, two feet in diameter, and emulating in height the tallest trees of the forest; *M. tripetela*, with its long narrow leaves; *M. macrophylla*, and *M. auriculata*, all in the same clump.

Some of the most remarkable beds of lignite in the State, are found upon each side of the point where the public road crosses the creek. On the west, the stream had encroached on the bank, and laid the deposit bare. The lignite has lost all traces of woody structure, is quite homogeneous and compact, resembling the black mud of peat-bogs, when partially dried. It is intersected by joints that cross it in various directions, and presents a sufficient disposition to split into laminæ, to remind one of cleavage. It is impossible, at this locality, not to recognise some of the steps in the conversion of vegetable matter into coal. This bed passes upwards into a black clay colored by intermixture with lignite, and rests upon a bed of blue

and fine sand, which is sometimes sufficiently indurated to form sandstone; the latter is better seen lower down the creek.

SECTION ON HORSE CREEK.

Surface beds.	
Dark clay.	3 feet.
Lignite.	3 feet.
Blue sand, and sometimes sandstone.	

About a mile from Choctaw Corner, a highly interesting locality was pointed out to me by Mr. Worrel: at this place, I saw the preceding bed of lignite, with the addition on the top of a bed of marl four feet thick, containing a considerable proportion of green sand, and having embedded in it *Cardita planicosta*, and other easily recognised eocene fossils; the whole resting upon a stratum of blue sand.

The following diagram exhibits the order of super-position, and thickness of the beds at this locality:

SECTION ON BASHIA CREEK.

1.	Hard limestone.	4 feet.
2.	Marl highly fossiliferous.	25 feet.
3.	Blue sand.	Variable.
4.	Lignite and clay.	6 feet.
5.	Laminated clay, sand, and mud.	Thickness undetermined.
6.	Lignite.	Do.

1. This is a bed of hard rock, differing in composition but little from the marl which underlies it, excepting in its greater hardness. It appears to overlie the marl pretty generally, for

I found it at localities miles distant. When cut through by the streams, or fissured (which is often the case) from any cause, the marl below is washed out, and caves of small extent are formed.

2. The marl of this bed presents all the characters of the substance so called in Virginia, excepting, perhaps, that the fossils are in a finer state of preservation, than any found in the eocene beds of that State. Green sand is also disseminated through this; all the dark-colored grains, however, do not belong to this mineral. Green sand is readily distinguished, by the green streak left, when a grain is crushed upon a piece of white paper, with the moistened point of a knife.

3. This is a bed of bluish sand, the thickness of which was concealed, as the section was only traced by following the stream in its downward course along its channel; the beds being often in part concealed by the sliding down of the surface beds.

4. The overlying black, tenaceous clay, and lignite of this part of the section, differ in no respect from a similar bed already described. In the laminated clay, leaves of Dicotyledinous plants are not uncommon.

5, 6—Represent beds seen on another part of the stream below the preceding.

The following are among the most abundant fossils at this locality:

Ostrea compressirostra.	*Volutata Sayana?*
Cytherea.	*Cardium Nicolleti.*
Cardita planicosta.	*Infundibulum trochiformis.*
Rostellaria velata.	*Solarium.*
Actæon pomilius.	

The oyster shells found here are large and ponderous, and resemble very closely a variety of *O. compressirostra* found on Santee canal, South Carolina.

Rostellaria velata has a longer and more attenuated canal than the Claiborne fossil. *Cardita planicosta* is in finer preservation than I have seen it elsewhere. The fossil that I have referred with doubt to, *V. Sayana*, at certain stages of growth,

has a thick callus on the columella, which partly conceals the spire.

Whether this be a prolongation of the Claiborne bed or not, I am as yet unable to decide. The mineral composition is different; and although the greater number of fossils are identical with those of Claiborne, yet as a group they are very distinct, besides containing forms not found at that locality. But these difference, considering the wide interval between the two localities, are quite consistent with their identity.

Five or six miles south of Choctaw Corner,* and on the east of the way to Macon, on the road to Tallahatta springs, thick ledges of rock are seen outcropping towards the top of the hills, and associated with a stratum of white silicious, and in some places indurated, clay. The surface of the beds of rock is often covered with silicified shells, much broken up, but often capable of being determined. I found here *Cardita planicosta*, and *Petcunculus idonea*. I traced these beds to Tallahatta springs, where, on the top of a hill, this rock had been quarried for millstones. The hills capped with this white silicious clay, conspicuous throughout this region, are known between the Springs and the Corner, as chalk hills. It was easy to recognise these beds, so characteristic of the buhr-stone formation of Georgia and South Carolina. Still, I am in doubt as to the position of this formation, in relation to the fossiliferous beds of Choctaw Corner.

The country is here really hilly and broken, and a ridge extends across to the west side of the Tombigby, where, 13 or 14 miles north of Barryton, it overlooks the valley of the river. Taken altogether, the buhr-stone formation gives rise to the most rugged and hilly region of the lower part of the State, and it is equally remarkable for sterility of soil.

On a stream, called in the neighborhood Etishlakare, about 15 miles north of Barryton, beds of marl occur similar to those on Bashia creek, and this is the farthest north that I have been able to trace them, and at this locality the order of superposition is equally uncertain. On many of the streams between

* This name is now transferred from the place indicated on the map, to where the post office is kept.

the Bladon springs and the locality just mentioned I found this marl, which every where contains a notable amount of green sand. This character and the fine state of preservation of the fossils, distinguishes this from the upper and more calcareous strata.

A short distance north of Barryton, below the mill dam, the marl has been denuded, over a considerable space, which is studded with the peculiar fossil oyster, *Ostrea sellæformis.* The bed exposed here is much more calcareous than those just described.

Desending the hill towards Bladon springs, the white siliceous bed is again exposed, showing that the waters of these springs, and those of Tallahatta flow from the same formation.

Leaving, for the present, the examination of the white limestone around the *Old* Court House of Washington County, let us pursue the study of the buhrstone farther south.

Baker's bluff is situated a few miles above St. Stephens; it is a vertical escarpment 50 feet in height and one fourth of a mile in length, composed of beds of indurated sandy clay containing casts of eocene shells and occasionally fossils completely silicified. The latter may be observed on the surface of the fragments strewed over the side of the hill at the southern end of the bluff. The shoal across the river between the bluff and St. Stephens, is produced by this rock, and not by the white limestone, as I have heard stated.

Inland from the bluff, and not far from the residence of Mr. Wilson, I found a bed of green sand, from which a salt spring issues, which was once used by the Indians, and still later by the whites, for the manufacture of salt; on tracing this bed into the hill sides, I found it rich in organic remains, identical with the fossils of Claiborne.

It is about eight feet in thickness, and occupies a higher position than the silicious beds at the bluff.

The following is a list of the fossils from this locality:

Rostellaria velata.	*Oliva Alabamensis.*
Pecten Lyelli.	*Monoceros alveatus.*
Cardita atticosta.	*Turbinella pyruloides.*
Crassatella protexta.	*Turrittella obruta.*
Astarte cellinoides.	*Corbula nassuta.*

Crepidula lirata.	*Mitra fusoides.*
Ancillaria staminea.	*Pleurotoma depygis.*
Dentalium.	*Infundibulum trochiformis.*
Natica limula.	*Bulla galba.*
Solarium elaboratum.	*Nucula ovula.*

Still farther south it is seen again, but is more calcareous, on a little stream that enters the river below the bluff; here it is fully 12 feet in thickness. This is at a lower level than the bed at Mr. Wilson's house, but above the level of the lowest stage of the river. About one half a mile above St. Stephens, immediately on the river, it occurs again, at a place called Harris's old landing. A short distance below this it may be seen dipping beneath the water-line towards the bluff at St. Stephens, at the base of which it is not seen, having dipped below it. This bed rises above the water ten or twelve feet, and was washed so as to exhibit a vertical bank. It is composed principally of ferruginous sand, and in mineral composition, and organic remains, it resembles the Claiborne bed. Vast numbers of Scutella Lyelli are found among the fossils. I examined the bed of the stream that flows into the river above St. Stephens, but did not find this stratum.

The hills back from the river are composed of a yellowish limestone, overlying the deposit under consideration.

Sir Charles Lyell has proved that the white limestone is newer than the fossiliferous bed at Claiborne, by showing that this bed, which contains identical fossils, underlies the bluff at St. Stephens. This is certainly the case, for although this bed is not seen at the base of the bluff, it is overlaid, as I have just stated, by a yellow limestone, which is a prolongation of that at St. Stephens.

Another locality occurs a few miles from Clarksville, on the land of Mr. Chambers, on the branches of Satilpa, where this fossiliferous bed is laid bare by the denudation of the upper beds, and appears in the bottom of a ravine, in the very midst of the white limestone, at a locality, too, where the latter rock is rich in the remains of Zeuglodon. At the old Salt Works, which is the lowest point to which I have traced the eocene beds of the State, there is a repetition of the sections of Bashia

creek and Baker's Bluff. At what is called the Upper Salt Works, there is a fine section of the lower beds, composed of lignite and indurated silicious clay, passing into a substance resembling chert or menilite, making a bluff 80 feet high. Near a mineral spring, I saw the lignite passing into black limestone, presenting a very interesting example of the replacement of wood by calcareous matter. In some masses of the rock, ligneous portions may be seen, whilst in others, the wood has completely disappeared, leaving a compact black limestone, susceptible of a polish, and as it is intersected by light-colored veins, it would form a handsome marble, could a bed of sufficient extent be discovered, which, however, is scarcely probable.

Nodules of rich-colored yellow ochre are found in the bed of the little stream at the base of the bluff; another point of identity with the buhr-stone formation of South Carolina, where a similar variety of this mineral occurs.

But the Lower Salt Works present a still more remarkable locality, for here we have the silicious beds quite hard, and even the green sand is much indurated. On the side of the road that leads from the works, as it winds up the hill, there is exposed a section showing the fossiliferous sandy bed overlying the silicious clay bed, precisely the position that this bed occupies at Baker's Bluff. The position of the salt spring at this place, is precisely the same as that of a similar spring at the last named bluff.

We have here, then, an interesting example of the sinking of strata below the surface, and their rising again. The beds exposed at Baker's Bluff, and still higher on the river, as well as on Bashia creek, after being depressed beneath St. Stephens and a portion of Clarke county, make their appearance again at this locality, and probably still farther west.

The white limestone, then, and other calcareous strata, occupy a deep basin, or trough-like depression in the buhr-stone formation. Whether the buhr-stone formation comes to the surface along the northern and southern boundary, beyond the points that I have indicated, I am unable to say. I have applied the term buhr-stone to this formation, because it appears to me a prolongation of that formation from South Carolina and Georgia.

1. It contains beds of silicified shells, cemented by silicious clay, although the shelly stratum is not so thick as that occurring in the States just mentioned, yet it has been used for millstones, as may be seen at Tallahatta springs.

2. The silicified shells are associated with a conspicuous white stratum, which accompanies it every where in South Carolina also. This bed is remarkable for its extreme lightness, considering that it is nearly pure silica.

3. It is here, as elsewhere, accompanied by a bed of green sand; add to these, that it occupies the same position in relation to the great calcareous, tertiary beds, and I think there can be no doubt of its identity with the true buhr-stone formation of the Southern States.

CLAIBORNE.

This locality is so noted, and has been described so often, that it may appear unnecessary to introduce a description of it here; but these accounts of it may not reach those into whose hands this report may fall, and besides, I examined it under very favorable circumstances; the water was extremely low, and a new inclined plane had been erected, so that the bluff presented a fresh surface from top to bottom.

It is a common remark of travellers, that the rivers of Alabama give no indication of their presence until one approaches their very banks. In general, they flow along narrow channels, excavated in the yielding calcareous rocks of the cretaceous and tertiary systems, and that have, in numerous cases, an artificial appearance, suggesting ordinary canals. Instead of the high land descending gradually to the river, there is usually a wide intervening terrace, of variable breadth, in which the bed of the river is cut.

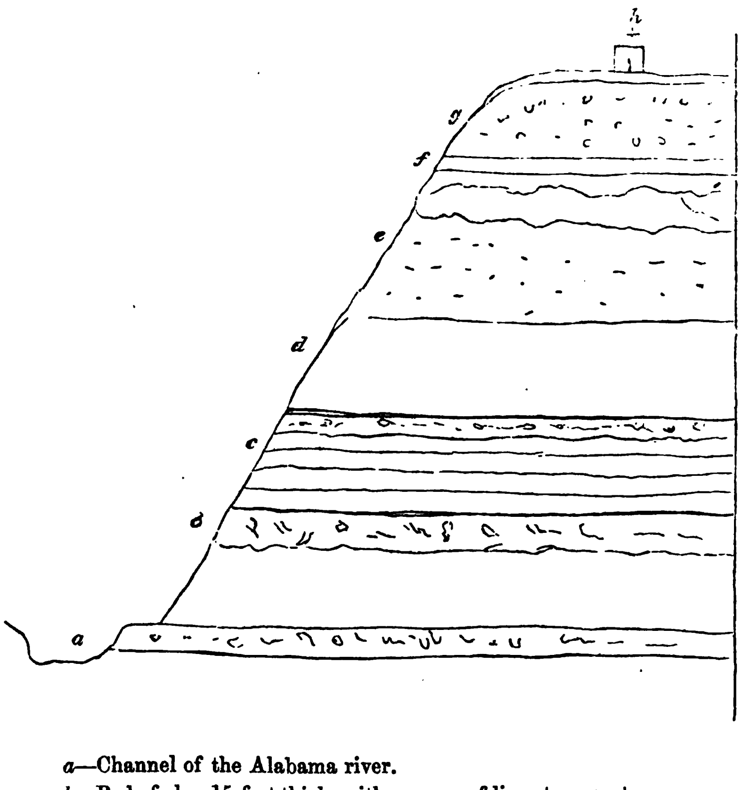
Claiborne, like many of the other towns on the rivers, is situated upon one of these terraces, which extends back to the ridge of white limestone that bounds it on the west: the highest part of this terrace is about 184 feet above the river at low water. The face of the bluff at this point is quite abrupt, and a railroad plane extends to the river for the convenience of landing goods, and freighting the steamboats.

The alternations of the beds that make up this part of the

formation, may be observed here, but the bed that has furnished the beautiful fossils, for which this locality is noted, is better seen at a point lower down, called the old landing, and at another place, between the two warehouses. The section represented here is taken at the new warehouse.

SECTION OF THE BLUFF AT CLAIBORNE.

FIG. 17.



a—Channel of the Alabama river.
b—Bed of clay 15 feet thick, with a seam of limestone on top.
c—Whitish limestone 62 feet thick.
d—Ferruginous sand and comminuted shells, with numerous fossils.
e—Limestone, 54 ft. thick, containing disseminated grains of green sand.
f—Mottled clay, 8 feet.
g—Red sand, loam, and pebbles, 30 feet.

At extreme low water, a portion of the bed *b* is exposed, which is more calcareous than the remainder, and which contains fossils that, as a group, are peculiar.

Turritella Mortoni, which is so small in the fossiliferous bed *d*, is here as large as it is found in Virginia. A species of anomia that I have not seen elsewhere, a *Cardita*, related to *C. planicosta*, described by Mr. Conrad as *C. densata*, occurs on the sloping bank of the river, buried in the marl, in the precise position in which kindred molluscous animals may be found in the mud between high and low water mark along the coast at the present day. The rest of the bed above this is chiefly argillaceous, but at the top there is a seam containing *Ostrea Sellæformis* of large size, and very ponderous. Indurated masses strew the base of the bluff, in which specimens of this fossil may be found with the valves united. I also found the remains of *Belosepia*, a genus new to our rocks.

c. This is a bed 62 feet thick, composed at the bottom of bluish marl, containing small shells, and passing upwards into whitish limestone, and terminating in a bed two to four feet thick, containing *O. Sellæformis* and *Scutella Lyelli*.

d. The sandy fossiliferous bed, the great source of the Claiborne fossils. It is exceedingly uniform, and may be traced along the whole face of the bluff. Among the fossils of this interesting locality, *Crassatella Alta* is conspicuous for size. It often occurs in the same horizontal plane, with the valves in juxta-position, and beautifully preserved. Although a great part of the bed is made up of broken and comminuted shells, yet it presents abundant evidence that the molluscous animals, the inhabitants of the greater part of these shells, lived and died where we find their remains.

I have specimens of this bed from Black's Bluff, which is the highest point on the river at which I have any knowledge of its existence. I saw it again a few miles below, on the side of a hill not far from the river.

e. This bed, which is about 54 feet in thickness, is composed of limestone, containing from 3 to 4 per cent. of green sand. The upper layer is quite hard.

f. A bed of white and mottled clay, containing no lime, that separates the thick superficial beds from the limestone.

g. This bed of red loam, sand and pebbles, is, like the pre-

ceding, entirely destitute of fossils; it is about 30 feet thick, and is found on the surface very generally throughout this entire region, covering both hills and valleys. The terrace upon which Claiborne stands is composed of this bed.

White Limestone.

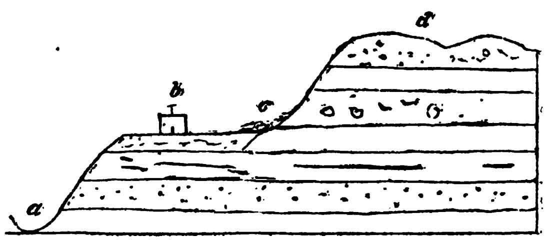
Wherever this bed of red loam is removed, the white limestone makes its appearance. Of this rock, an admirable section occurs on Randon's creek, where a channel has been cut in the rock, that is 20 feet deep, at the same time a deer could bound across it. The banks are quite perpendicular, and the whole has the appearance of an artificial canal.

Both here and on the hill-side, the white and chalky limestone is filled with the curious fossil coral, now called *Orbitoides Mantelli.* With the exception of this fossil, *Pecten Poulsoni*, and *Scutella Rogersi*, organic remains are not abundant in this rock. From the creek the rock rises, and may be traced to the brow of the hill, in the ridge one mile west of Claiborne.

Fig. 18 represents a section from the river bluff west through Claiborne.

Section showing the position of the white limestone in Monroe County, west of Claiborne.

Fig. 18.



a—The bluff.
b—The terrace upon which Claiborne stands.
c—White orbitoides limestone.
d—Beds of red loam and sand, the same as those on the top of the bluff at Claiborne, and upon which the town stands.

Remains of Zeuglodon occur in the limestone west of Claiborne. On the opposite side of the river, this rock is seen on the road, and apparently corresponds with the bed immediately over the shelly stratum at Claiborne.

Three miles from Suggsville, the white soft limestone is seen occupying the crest of Bettis's Hill. A quarry had been opened in it here, for procuring building stones for chimneys. It contains concretionary iron pyrites in nodules, sometimes elongated and cylindric, which are found troublesome when encountered in the process of sawing out the blocks of stone, and as they are often converted into oxide of iron, they explain the origin of the accounts given of nails having been found in the interior of this rock. On the roadside, areas of some extent are uncovered and level with the surface, producing bald spots similar to those found where the cretacéous limestone comes to the surface. These spots are generally productive in fossils, for when the marl that enclosed them is washed away, they remain scattered over the surface. *Echinoderms*, and casts of a species of *Cypræa?* marked with regular grooves, are quite common.

Next below this stratum, which abounds in *Orbitoides*, there is a harder and more fossiliferous bed that outcrops around the hill. Fishes' teeth are numerous at this locality, and in general, the fossils of the white limestone are pretty well represented. The following are the fossils found here:

Pecten Poulsoni.	*Trochus.*
" *perplanus.*	*Scalaria.*
Plagiostoma dumosum.	*Conus.*
Ostrea panda.	*Orbitoides Mantella.*

Between this hill and Suggsville, the limestone is exposed wherever the red loam has been removed, and within half a mile of the latter place, an elevated point is capped with a hard yellow limestone filled with *Orbitoides*, and where it is weathered, it presents a curiously embossed surface.

The fine groves of native trees in and around this village, added to its elevated site, give it a pleasing appearance, when contrasted with the surrounding hills of naked limestone.

West of the village, there is another quarry, where building materials were procured, on the top of the hill. The stratum containing the fossil *Orbitoides* is generally chosen for this purpose, because it is softer and more homogeneous in structure. The mass of the rock is made up of comminuted corals, and grains of carbonate of lime that have a concretionary appearance, and sometimes are crystalline. This is the general character of the rock wherever found. Vertebræ of *Zeuglodon* are found here, and an important part of the specimen of this animal now in Boston, was found near Suggsville. There are few localities of this white limestone, where the remains of the huge cetacean the *Zeuglodon* are not found. Scarcely is there a field around Clarkesville in which they do not occur; and at the first settlement of the country, the enormous vertebræ of this animal were used for andirons, by the inhabitants, and even now, remains may be found among the ruins of the houses, that had been used for that purpose.

In Choctaw county, I found 22 vertebræ in juxta-position. And at the same locality the skeleton of a small individual, but much decayed.

For the greater part of the way between Suggsville and Jackson, the beds of brick-red loam are found on the surface, and the plain upon which Jackson stands, is composed of these beds, which may be studied in the deep ravines that are fast encroaching upon the very streets. Between the town and the river, they are excavated of great depth, and beds may be seen that cannot be distinguished from those around Tuskaloosa.

The nearest point towards the buhr-stone of Bashia creek, that I have seen this white limestone, is near Macon. Specimens may be seen in chimneys in the country around the Court House.

ST. STEPHENS.

The bluff at St. Stephens, like that at Claiborne, has been long known to geologists, and the identity of its rocks with the white limestone of the Santee, in South Carolina, was established by Mr. Conrad, who, misled by some of the embedded fossils, referred the whole to the upper part of the cretaceous system,—supposing, as I have said in another place, that the

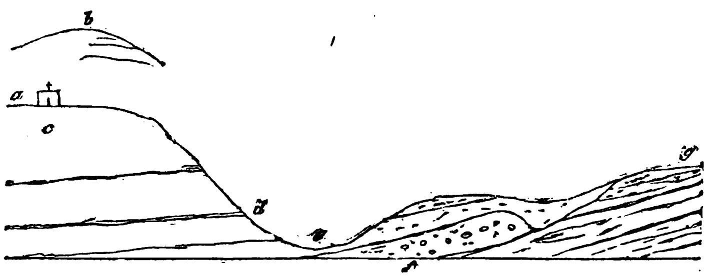
Claiborne bed was newer, instead of being, as we now know it to be, older than the white limestone.

It is curious to observe, after the difficulties have been cleared away, that surround pioneer explorations of every description, how obvious every thing appears, and how difficult it is to account for the mistakes of our predecessors. But in the present instance, it must be recollected, that the Claiborne fossiliferous bed is no where found in absolute juxta-position with the overlying orbitoides limestone, and even at St. Stephens, I was unable to detect it at the base of the bluff, although I examined it at an unusually low state of the water. Nevertheless, the position of the bed above the bluff, together with its dip, leaves no doubt of its sinking below the white limestone.

The section at St. Stephens presents nearly all the series, down to the bed to which I have just alluded, as may be seen in Fig. 19.

SECTION FROM BAKER'S BLUFF TO ST. STEPHENS.

FIG. 19.



a—Site of old Spanish fort on bluff.
b—Hill back of the town.
c—Upper stratum of bluff.
d—Lower stratum, forming a terrace above low water.
e—Bed of a stream emptying into the river above the bluff.
f—Bed containing Claiborne fossils.
g—Buhr-stone formation of Baker's Bluff.

The bed represented at *b*, is soft white limestone, abounding in *Orbitoides Mantelli*,* *Pecten Poulsoni*, *Scutella Lyelli*, and *Scutella Rogersi*. The remains of old quarries are every where evident at this locality. Although the orbitoides bed is generally on top, strata containing that fossil are found in the bluff at various levels.

c, Is a thick bed of hard limestone, forming the most conspicuous part of the bluff, and that upon which the old fort stood.

At the south end of the bluff, a quarry was once opened, and orbitoides occur there also: its presence would seem always to indicate the variety of this rock adapted to building.

In the lower strata *d*, there are hard seams that stand out in ledges above low water, and upon these I found *Plagiostoma dumosum*. These beds are much darker colored than the superincumbent ones.

f. This is the bed described in the preceding pages, as extending from Baker's Bluff to a point about half a mile above St. Stephens; and it was from this bed the fossils were taken, which were sent by Prof. Brumby to Sir Charles Lyell.†

g. Baker's Bluff. The cherty and silicious beds are finely developed here, and their relative position shown. Sir Charles Lyell has associated these beds, both in Alabama and South Carolina, with the newer brick-red beds of loam, gravel, &c., that overspread the surface.

When the white limestone is carefully examined, I think that the organic remains found in it will not differ so widely from those of the famous Claiborne bed, as, at present, they appear to do.

In the limestones, corals, and the enduring shells of mollusks of the family *ostracea*, together with the remains of echinoderms, alone are found, whilst other fossils occur only in the state of casts, and even these are but rarely well preserved. In the white limestone of Cedar creek, I was able to identity

* From some recent examinations of this curious fossil by Mr. Carpenter, (Quar. Jour. Geol. Soc., Feb. 1, 1850,) it appears to be identical with a species from the Nummulite limestone of north-western India.

† Jour. Geol. Soc., Feb. 1, 1848.

several casts of Claiborne fossils, and among them *Cardita planicosta* and *Turritella Mortoni.*

Cedar creek empties into the Alabama river below Claiborne, but on the opposite side. The exposures of white limestone here are exceedingly interesting. The surface is much broken up into rounded hills of slight elevation, that, with their thick covering of cedars, have a picturesque appearance. Mr. Forbes has appropriated one of these knolls as the site of his house; the lawn is enclosed with a wall composed of the harder portions of the limestone, and this is the second instance that has come under my notice, of the use of the limestone of the newer formations in the construction of permanent fences.

The limestones are composed of alternating hard and soft beds, and as the latter are washed away, the harder strata stand out in terraces that have the appearance of artificial road-ways excavated around the hills. The bald snow-white spots, covered with the most magnificent cedars, present a very striking appearance. The level parts of the country intervening between the hills, are covered with a dark-colored and fertile soil, particularly on the banks of the creek; it is often mixed with bog-iron ore in the form of globules the size of buck-shot, but I found no beds of this ore.

Although the lower silicious strata are found here, I did not find the sandy fossiliferous bed, yet it occurs not far from the nearest landing on the river.

These irregular patches of white limestone, that are laid bare by the denudation of the superficial beds, give a pleasing variety to the counties occupied by the tertiary of the State. From the Salt-works to Cedar creek, the country is one unbroken, but magnificent pine forest, and from the preparations for the manufacture of turpentine that I observed on the way, these forests will not remain long unproductive.

Superficial Beds.

I have in the preceding pages referred to beds of loose materials composed of pebbles, sand, clay and loam, that are found scattered over the State, often completely hiding the underlying rocks. These may be studied to great advantage around Tuskaloosa, where they are fairly displayed on the slope of the

hill towards the river, affording a striking illustration of the causes that are daily modifying the earth's surface.

The upper bed is composed of red loam, and is underlaid by yellow and white sand, showing oblique lamination. These beds alternate with deposits of coarse quartzose pebbles of various colors; among these are often found agate, jasper, hornstone, and other varieties of quartz. The largest of the pebbles rarely exceed four inches in diameter.

Occasionally, rounded fragments of the sandstone of the coal measures may be detected, and in a few instances, I have found pieces of millstone grit much larger than the pebbles. But the most interesting portion of these materials consists in the cherty pebbles having an oolitic structure, that give intelligence of the origin of the beds in which they are contained.

I have stated, that in the lower group of carboniferous rocks, there are beds of chert that are in structure oolitic. These beds, it will be recollected, extend as low down as Village Springs; it is the ruins of these that have furnished the oolitic pebbles. Hornstone and agate also occur in these beds, and are doubtless the origin of the pebbles of these minerals, to which I have alluded. The degradation of the conglomerate of the millstone grit of the valley, has also contributed quartz pebbles, and other silicious materials. But we are not left altogether to infer from identity of mineral composition, that the loose materials that cover the surface around Tuskaloosa have travelled from north to south, from 100 to 150 miles, for we can trace the very path they travelled, by the monuments they have left behind them on their journey. Along Jones's Valley, beds of pebbles may be traced, in spots beyond the influence of any cause now in operation, that could place them there. And almost in the streets of Elyton, Dr. Earle directed my attention to a low and narrow ridge composed of these materials; add to this, that I have found at Tuskaloosa in these beds, fossil corals, and among them a species of *strombodes*, a carboniferous fossil, and I think there can be but little risk in stating that the materials of these beds have travelled at least from the lower edge of Blount county. Within a very few years, they have again taken up their line of march, and are fast hastening on their downward course from Tuskaloosa. Tons are transported to the river by every shower of rain, and

the only wonder is, that the navigation of the Warrior has not long ago been impeded, by this vast accumulation that is taking place in its bed.

These deposits have been confounded with the silicious beds of the cretaceous formation, but even in the absence of fossils, their mineral composition when carefully studied will always distinguish them; the cretaceous beds contin no oolitic pebbles, and rarely pebbles of any sort. But the cretaceous beds, wherever I have examined them, do contain fossils.

I have traced these superficial beds as far as Jackson, Clarke county, and find their composition the same. In Greene they are reduced to mere knolls, scattered here and there over the prairies. Lower down, these are seen in the terraces on the rivers, as at Cahawba and Claiborne, and generally filling depressions in the white limestone, but often covering the tops of hills. A few miles east of Cahawba on the land of Mr. Watts, I found beds with pebbles, as large as those found at Tuskaloosa, together with fragments of talcose rock, showing that in their course these materials had passed over the metamorphic rocks of the eastern part of the state. I have stated that at Jackson, beds of great thickness occur, made up of pebbles, loam and mottled clay; here I found the oolitic pebbles again, quite abundant.

Seeing then, that these beds present this remarkable identity of mineral composition, and moreover that they may be traced at intervals, as far at least, as Jackson, where they overlie the white limestone, I am obliged to conclude that the beds around Tuskaloosa, instead of being the oldest of the cretaceous rocks, are newer than the eocene tertiary of the State. What becomes of them lower down, toward Mobile, I do not know, nor am I able to add anything further in relation to their precise age.

Organic Remains.

Of course the fossils of tertiary have received a due degree of attention, although I have introduced lists of them sparingly, and only for illustration and comparison. The rest must be reserved for another occasion, when materials shall have been collected for a complete synopsis of the palœontology of

Alabama. The generic identity of the remains of vertebrate animals, with those of South Carolina, is as remarkable as that observed among the remains of mollusks. Besides the remains of sharks, including *Coprolites*, we have *Cœlarhyncus*, *Pristis* and *Divdon*, together with a few forms peculiar to our formations, such as *Lepidotus*.

Post Pliocene.

This formation occurs, I understand, around Mobile. As I have not yet visited that region, and as this report is necessarily a record of my own observations, so far as the geology of the State is concerned, I can say nothing of the beds that occur there. Both Mr. Hale and Prof. Brumby have written upon the Post Pliocene of the State; but, unfortunately, I am unable to refer to their papers.

Recapitulation.

1. The Tertiary rocks of Alabama, so far as they are yet known, belong to the oldest, or eocene division of the system, and are a prolongation of the eocene rocks of South Carolina and Georgia.

2. They consist of two groups, distinguished by difference of mineral composition. The one called the buhrstone formation, contains a bed of silicified shells, associated with a stratum of white silicious clay, which is often cherty in structure. This group is at the base of the system, as I have shown in the preceding pages. In the final report on the geology of South Carolina, I have also shown that it occupies the same position, and is overlaid by the calcaseous beds.

3. The other group consists of the well known white limestone of Monroe, Clarke, Washington and Choctaw counties. This rock is characterised by the remains of Zeuglodon, an enormous animal related to the Whale tribe, which is represented in the eocene limestone of South Carolina by an allied genus called Phocodon, by Prof. Agassiz.

The Alabama fossils agree with those of South Carolina, as was first pointed out by Mr. Conrad. They also agree in the

vast number of Placoid fishes, of the same genera, that they contain.

4. It is obvious, that whatever doubts may be entertained of the age or geological position of the white limestone, when compared with European formations, they must apply to the great calcareous beds of that State.

Besides the proofs presented there, I have recently seen specimens of chert brought up from below the marl, in the Artesian well in Charleston, and from a depth of seven or eight hundred feet. Of its position in Georgia, where Sir Charles Lyell found silicified shells in beds, which he supposes the equivolent of the red loam that is on the surface in Alabama, I know nothing. I have shown in the report referred to, that the fossils of the South Carolina buhrstone, are identical, for the most part, with those of Claiborne, aud also agree with lower beds of the Virginia eocene of the Pamunky. The Claiborne bed occupies the same position, as the bed of silicified shells in South Carolina, namely, above the cherty silicious clay, and immediately below the white limestone. So that whatever doubts, may arise as to the age of these beds, they must apply to the whole of our eocene. We have not yet, I apprehend arrived at the time for the full discussion of this interesting point; our collections are not complete enough, even for the comparison of our own strata with each other, to say nothing of their comparison with foreign equivalents; but already we have collected a sufficient number of facts to teach us caution. I have elsewhere shown, as others did before me, that there are fossils common to our, so called, eocene and cretaceous beds; I have now, from the white limestone of Alabama, a fossil fish which Prof. Agassiz recognises as identical with one from a formation in Brazil, which he thinks cretaceous;* and nothing but the microscopic characters of the teeth of fossil Placoids will enable us to distinguish the forms, (supposing them to be different) common to the cretaceous, and tertiary beds of the United States.

As to the position of our rocks in the American scale there

* Comptes Rendus Tom. XVIII, 27 mai 1844.

can be no question, the merest beginner in geology can distinguish our cretaceous rocks from our lower Tertiary, or what we call eocene; and the latter is equally distinct from our middle tertiary; but when we compare them with European formations, in order to decide whether they are the equivalent of the calcaire grossier of the Paris basin, the Nummulite limestone of Biaritz, or of certain supposed beds of transition between the cretaceous and tertiary systems, then the case is different, and may admit of doubt, but it must apply to the whole group, and not to a part of it.

5. The superficial beds of red loam, pebbles &c, that cover the tertiary of Clarke, are identical with those about Tuscaloosa, and were transported from north to south. They extend across the State hiding the junction of the cretaceous and older rocks; and must not be confounded with the lower cretaceous beds. They contain no fossils, and therefore thier age can only be inferred from their position—they are newer than the white limestone, but their position in relation to the Post Pliocene around Mobile is yet undetermined.

Marl and Lime of the Cretaceous and Tertiary Systems.

The term marl is applied by European agricultural writers to any clay containing an appreciable quantity of lime; but in this country, Edmund Ruffin, Esq., of Virginia,* who is our best authority on this subject, has restricted the term to the deposits composed of clay, sand, and lime, derived from fossil shells. In New Jersey, the name is applied to the cretaceous green sand of that State, which frequently contains not a particle of lime.

From what has been said of the rocks of the cretaceous and tertiary systems of Alabama, in the preceding pages, it will appear that all the calcareous rocks appertaining to them come under this definition, so that they may be called marl, or marlstone, according to the degree of induration that they present.

In every country where agriculture has made any real progress, lime is ranked amongst the most important fertilizing

* "Essay on Calcareous Manures," a work replete in all information relating to marl.

ingredients, and every one who is at all acquainted with the progress of agriculture in the United States, must be familiar with the estimation in which lime is held in Pennsylvania and Virginia. In Pennsylvania, lime-burning for agricultural purposes is an important business, and in Eastern Virginia, that form of carbonate of lime called marl, has been used for the last 20 years.

In whatever form the lime is applied, the amount of that substance present, is generally considered the standard of its value, and agriculturists speak of marl and calcareous manures in general, as rich or poor, strong or weak, in proportion to the per centage of carbonate of lime present in them. The marls of Virginia contain from 25 to 60 per cent. of carbonate of lime, and the greater part of the marl used there does not exceed 40 per cent.

The rotten limestone of our cretaceous formation has an amount of lime varying from 25 to 45 per cent.; while the white limestone of the tertiary formations has as high as 95 per cent. of carbonate of lime, and they both frequently contain phosphate of lime in notable quantity. The marls of the State are so situated, as to be often surrounded by poor silicious soils deficient in lime. To such soils the argillaceous rotten limestone of the prairies would be an excellent application; and even the deep soils overlying this limestone, where they have been long cultivated, may be deficient in lime, near the surface, and if so, would be greatly benefited by a top-dressing of marl. We have as yet no experiments to guide us in the application of marl, which, after all, present the only safe guide, especially as there appears to be some diversity of opinion among planters at the South in relation to the practice of marling, and even to the results produced by it. In South Carolina, it has not met the expectation of planters in general, although many have been eminently successful in its use.

There will always be failures in the application of every new process, arising from want of correct knowledge as to the principles involved in it, or from the disregard of those principles. Mr. Ruffin has always inculcated caution in the application of marl, and has very clearly pointed out the usual causes of failure. In allusion to the apparent want of success in South Ca-

rolina, he writes:* "I have been induced to publish a statement of the expenses and profits of my farming operations for the years since I left South Carolina. The article shows the *returns* from marling, as my former communication to the State Agricultural Society of South Carolina showed the cheapness of the operation, the series I thought well suited to convince your countrymen, by *facts* and my labors, in the short time since I left South Carolina, of what I failed to impress on them by my reasoning and efforts of persuasion. But I fear that nothing can induce them to marl *in the proper manner*, even when doing any thing in that way. I have been grieved to hear that all my preaching on this subject has served to do but little good even to my few converts; and they on whose example and labors I relied, to justify all I have urged, have failed to realize any *great* improvement. Their failure is due to the same cause, viz: not giving the land rest, and the time and means to supply itself with vegetable matter in proportion to the amount of lime supplied. In the few small cases in which this was done, (by accident, rather than design,) before I left South Carolina, and which was duly reported, the success of the marling was most signal, and might have been so in every case, by meeting the same requirements. This is the whole cause of difference of results between South Carolina marling and mine. What I then *taught*, I have since (as well as before) *practised*. Judging from my results of such *practice*, what would have been the increase of general wealth in South Carolina, if every planter, having access to calcareous manures, had, during these five years, been improving in the same manner?"†

I know not how better to recommend this subject to the attention of our planters, and to enable them to avoid mistakes, than by pointing out to them briefly the mode in which calcareous manures in general operate, in producing their known effects in the soil:

1. A certain amount of lime is found in all plants, and we

* Southern Quar. Rev., p. 162, Oct. 1849.

† Mr. Ruffin's "Statement of Expenses and Profits" appeared in the Am. Far., Vol. 5, No. 1, July, 1849.

must therefore infer that it constitutes a necessary ingredient in their proper food: besides, many of our marls contain phosphate of lime, a highly valuable substance.

2. It neutralises the injurious effects of certain noxious salts that may exist in the soil, such as sulphate of iron, &c., by decomposing them, and thereby often converting them into valuable fertilising ingredients, as where sulphate of iron forms sulphate of lime, or gypsum.

3. It promotes the decomposition of vegetable matter that may be in the soil, such as the roots and other remains of the preceding crops; and by thus bringing it into that state in which it absorbs nitrogen, it converts inert vegetable matter into a highly valuable manure. Decomposition of such matter is promoted by the neutralisation of the organic acids generated during decomposition, and which are highly antiseptic.

4. It also acts as a solvent of the silicates in the soil, which would otherwise remain there as useless constituents.

5. Lime acts mechanically on the soils by altering their physical properties; and in this way stiff clay soils are rendered less tenaceous, and light soils have their retentive power increased.

Important as lime is as a constituent of plants, it is obvious that its principal value is due to its action on the materials of the soil; and hence no one would think of applying it directly to the roots of plants, as other manures are applied, that contain several ingredients, and act chiefly by furnishing nutriment. Its greatest effects are produced, where it is intimately mixed with the soil; but no specific rules can be given as to the quantity to be applied to a given space. What would be excellent practice in one place, would be ruinous in another—500 bushels of caustic lime are often applied to an acre of land in England, while with us 30 to 40 bushels is considered a dose that may not be exceeded without danger. Of course, the more organic matter in the soil, the greater the quantity of lime that may be applied, and on poor sandy soils, without the addition of vegetable matter, it may be hazardous to apply any. As an illustration of this, I may mention, that I saw cotton growing in the rich vegetable mould of the cane-brake, mixed with so much marl that I am certain, in less favored soils, it would prove ruinous. A greater quantity of marl may be

applied, of course, than of caustic lime. The dose will vary with the strength of the marl, as well as with the circumstances just mentioned; for instance, a greater quantity of the rotten limestone may be applied than of the white limestone of Clarke. In general, the quantity may vary between 150 and 200 bushels, but in the absence of experiment, it will always be prudent to proceed cautiously, to add organic manures, and, if possible, to apply the lime or marl before the fallow.

The green sand of Clarke and Choctaw require the same caution, not on account of the green sand, but the lime, for the beds, as I have stated, are rich in that substance. In New Jersey, where green sand abounds, it is often applied at the rate of 400 bushels per acre, and is frequently brought from a distance of many miles.

It would be difficult to find a region better supplied, than Alabama is, with this highly valued means of improving the soil, whether we consider the richness of the marl, or the ease with which it may be procured.

There is, as I have stated, great difference in the agricultural value of the various beds of marl, and even in the same bluff, the amount of lime varies between wide limits; thus, at Claiborne, the lower bed next the river does not contain more than 20 per cent. of carbonate of lime, whilst the shelly stratum has 50, and the overlying white limestone 60 per cent. It would be no difficult labor to raise marl from the face of the bluff, as the plane and machinery are already erected. The green sand bed at Baker's Bluff contains not more than 5 or 6 per cent. of lime, at the same time that the grains of green sand constitute 33 per cent. of the entire mass.

But the white limestone, and particularly that portion of it, containing the coral *Orbitoides*,* surpasses all the rest in amount of lime; it is in truth nearly a pure carbonate of lime, and, in general, contains over 95 per cent. of that substance.

This is the rock used for the construction of chimnies in Clarke, but its fire-proof character is the most remarkable. The heat of an open fire-place is not intense enough to drive off the carbonic acid, and the rock is porous enough to allow

* This is circular disk about the size of a 25 cent piece.

the escape of moisture, and expansion, without cracking. It is surprising that this rock has excited no interest out of the neighborhood where it occurs, considering its peculiar adaption to the construction of domestic fire-places.

MINERAL SPRINGS.

The tertiary formations of the United States are not remarkable for the mineral character of the water, yet in the Alabama tertiary there are several springs of very marked properties.

I have stated that a stratum associated with the buhr-stone gives rise to several saline springs, that have been used for the manufacture of common salt. Besides these, there are others strongly impregnated with sulphuretted hydrogen. One occurs at the lower salt works, which is quite strong; and another at the upper salt-works. Both of these are places of occasional resort for invalids.

Tallahatta springs are well known, and much frequented by citizens of that part of the State: besides sulphur, the water contains salts of iron, lime, and magnesia.

Of all the springs of this region, those of Bladon are deservedly the most noted. The water has been analysed by Prof. Brumby, but as the analysis was executed at a distance from the spring, and no precautions taken to preserve the gaseous ingredients when the water was transmitted to the Professor, of course the sulphur does not appear in his analysis, and one is therefore surprised to find the Bladon Springs among the strongest sulphur springs in the State. The springs are pleasantly situated, and at the proper season, very accessible from the Alabama river.

I cannot close this slight notice of the springs of the tertiary formation, without mentioning one west of Claiborne. It is situated in the superficial beds of red loam, and is purely a chalybeate spring, and by far the strongest that I have seen in the State.

GLOSSARY

OF

GEOLOGICAL AND OTHER SCIENTIFIC TERMS.

Adit, a level entrance to a mine.

Algæ, an order of plants, principally sea-weeds.

Alkali, a chemical substance, such as potash and soda.

Alluvium, loose materials, pebbles, loam, &c., brought down by rivers and floods, and again deposited.

Ammonite, an extinct genus of molluscous animals, related to the nautilus. The fossil shell is frequently taken for a snake in its coil.

Amorphous, presenting no definite form.

Amygdaloid, a rock of the trap family, having rounded simple minerals disseminated through it.

Antennæ, the horns or feelers of insects.

Anthracite, coal containing no bitumen, and consequently giving out but little flame.

Anticlinal axis, a line towards which raised strata lean.

Antiseptic, a substance that prevents putrefaction.

Arenaceous, sandy.

Azoic, without life. The rocks that contain no organic remains, are called azoic.

Basalt, a dark-colored heavy rock, which often assumes a columnar structure, as seen at the Giant's Causeway. A common variety of trap rock.

Bed, a layer between two strata.

Belemnite, a fossil resembling a dart. A genus of the order cephalopoda.

Bitumen, the tar-like substance that oozes from bituminous coal, when heated.

Bituminous shale, shale containing bitumen.

Botryoidal, resembling bunches of grapes, a form that minerals sometimes assume.

Boulder, large blocks of stone that have their corners rounded off, and that have been transported from a distance.

Breccia, a rock made up of angular fragments cemented together.

Buhrstone, a silicious and porous rock used for millstones.

Calcareous, composed of, or containing lime.

Calcareous spar, crystalized carbonate of lime.

Carapace, the shelly, or bony covering of the back of certain animals, as the terrapin, crab, &c.

Carbonate of lime, lime combined with carbonic acid.

Carbon, a simple substance, of which charcoal is chiefly composed.

Carbonic acid, a heavy gas, produced by the combination of oxygen and carbon.

Cephalopoda, a class of molluscous animals, having the organs of locomotion around the head.

Cetacea, a group of animals related to the whale.

Cleavage, lines in which certain slaty rocks split, which differ from the planes of deposition or bedding planes.

Clinkstone, a rock that gives out, when struck, a sound resembling that of a metal.

Conformable, when beds lie upon each other, with the bedding planes parallel.

Congeners, species of the same genus.

Conglomerate, a rock composed of rounded pebbles cemented together.

Crater, the cavity on the summit of a volcano.

Cretaceous, a word derived from the Latin name of chalk, and is applied to the geological formation in which chalk is found.

Crop, the appearance at the surface of beds or strata.

Crust of the earth, the superficial portion of the earth—that part upon which we live.

Crustacea, a class of animals resembling the crab, craw-fish, &c.

Crystal, a mineral having a regular form.

Chert, a mineral resembling flint.

Delta, the loose beds of alluvial formed at the mouths of rivers.

Denudation, the laying bare, by water, or other causes, the surface of the earth.

Diagonal stratification, the lines in which loose materials arrange themselves when pushed forward by water, and which are diagonal in relation to the bedding planes, or lines of stratification.

Dikes, masses of rocks of igneous origin, filling cracks in other rocks as if pushed up from, below.

Diluvium, accumulations of gravel, &c., supposed by some to be produced by a deluge.

Dip, the inclination that strata have with the horizon.

Eocene, the oldest of the tertiary formations.

Fault, the interruption of the continuity of a bed; often occasioned by trap dikes.

Fauna, the animals of a country.

Flora, the plants of a country.

Felspar, one of the constituents of granite, composed of silica, alumina, and potash.

Ferruginous, containing iron.

Fluviatile, belonging to a river.

Formation, the name for a group of rocks.

Fossils, animal or vegetable remains found in the earth.

Fossiliferous, containing fossils.

Fucoid, a fossil resembling sea-weed.

Galena, a mineral composed of sulphur and lead.

Glacier, accumulations of ice and snow on the tops and sides of mountains.

Gneiss, a stratified rock composed of the same materials as granite.

Greensand, beds containing grains that give a green streak when crushed.

Greenstone, a variety of trap.

Greywacke, coarse silicious rocks.

Grit, coarse-grained sandstone.

Gypsum, a compound of lime and sulphuric acid.

Hornblende rock, a rock composed in part of a dark-colored mineral called hornblende.
Hornstone, a mineral like flint.

Iceberg, immense masses of ice found floating in the ocean.
Ichthyosaurus, an extinct marine reptile.
Igneous, relating to fire.
Infusoria, minute living creatures found in vegetable infusions.
Isothermal, a name applied to zones on the earth's surface, having an equal mean annual temperature.

Joints, fissures intersecting rocks, often extending to a great distance in straight lines.

Laminæ, the thin layers of a rock.
Lava, the melted matter that flows from a volcano.
Lignite, wood converted into brown coal.
Lithological, the character of a rock, depending upon its mineral composition.
Littoral, belonging to the shore.

Mammoth, an extinct animal related to the elephant.
Marl, a mixture of clay and lime.
Mastodon, an extinct animal related to the mammoth, but may be distinguished from that animal by the conical prominences on the crown of the teeth.
Matrix, the rock in which a mineral is enveloped.
Metaliferous, bearing metals.
Metamorphic, altered by heat.
Mica, a mineral called in this country, erroneously, isinglass.
Mica slate, a rock composed principally of mica. One of the oldest stratified rocks.
Mollusca, animals that have no bones, such as the oyster, &c.

Nodule, rounded irregular lump.

Oolite, a limestone composed of minute round particles like the roe of an egg.
Outlier, a portion of a stratum found at a distance from the mass.

Oxide, a metal united with oxygen.

Palæontology, the science relating to fossils.
Palæozoic, ancient life or being: applied to those rocks that contain remains of the first forms of life that appear on the earth.
Plesiosaurus, an extinct saurian related to the lizzards.
Pliocene, the upper division of the tertiary formation.
Porphyry, a rock made up of crystals embedded in a base composed of a different mineral.
Puddingstone, the same as conglomerate.
Pyrites, a yellow, brass-like mineral, composed of sulphur and iron; often mistaken for gold.

Quartz, a mineral composed of pure silica.

Sandstone, a rock composed of grains of sand cemented together.
Saurian, an animal related to the lizzards.
Schist, a slaty rock. More commonly applied to those slaty rocks that do not split into laminæ like clay slate.
Seam, a thin layer.
Shale, indurated clay slate.
Shingle, water-worn gravel on the sea-shore.
Silica, the earth composing quartz or flint.
Silicate, a compound of silica and a base, as silicate of lime, composed of silica and lime.
Silicious, composed, for the most part, of silex.
Silicified, when silica has replaced the original particles of a substance, it is said to be silicified; as silicified wood.
Silt, the fine matter brought down by rivers.
Shaft, a pit, or vertical entrance to a mine.
Stalactites, long conical forms of carbonate of lime, found suspended from roof of caves.
Stalagmites, similar bodies formed on the floor of caves, by the dripping of water containing carbonate of lime in solution.
Stratified, arranged in beds or strata.
Stratum, a bed or mass extending over considerable space.

Strike, the line of direction or bearing of the edges of rocks.
Sienite, granite in which hornblende has taken the place of mica.
Synclinal axis, the opposite of anticlinal axis.

Tertiary, the formation next above the cretaceous.
Thin out, a bed, or stratum, is said to thin out, when it gradually lessens in thickness, till it disappears altogether.
Trap, certain forms of basaltic rocks.
Tufa, a porous deposit left by water, containing carbonate of lime in solution.

Veins, fissures, or cracks in rocks, filled with mineral matter.

Wacke, a soft variety of basalt.
Weathering, changes produced on the surface of rocks by exposure to the weather.

Zoophites, corals, and other lower animals, that remain attached to rocks like plants.

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